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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Health at School.

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No. III.—DRAINAGE (*continued*) AND WATER SUPPLY.

TRAPS, to say the least of them, are broken reeds to lean upon. In dry seasons, the water upon which their efficiency depends evaporates, and at the very time when they might possibly be of service, viz. when putrefaction is taking place in consequence of the heat and dryness of the season, and foul gases are being evolved, the water which was in the trap has disappeared. Taken as a whole, a system of drainage which depends upon traps for its efficiency is a bad system. When sewers are dependent upon water-traps for protection against the invasion of sewer air, the protected buildings will sooner or later suffer for the confidence which has been placed in them. Sometimes, however, it is wise to choose the least of two evils, and to have a trap placed in some position, notwithstanding its defect when it is employed as the only protector. Thus, when it is necessary for the rain-water pipe to discharge itself into a sewer, the junction should be trapped. It is safer to trust to a trap at this point than to leave the rain-water pipe untrapped, or to make it loose upon a trapped grating at the level of the soil in the play-ground, that is, if the gully into which it discharges is connected with a closed sewer. Dipstone traps, as they are called, are very common arrangements in country districts, and country builders seem to put them in as a matter of course, and consider them marvels of perfection, but they are very objectionable. Gullies of a similar character should be prohibited in all plans for draining school buildings: any kind of arrangement which interferes with that grand canon law in all drainage work, viz. Motion, is wrong in principle, and should not be allowed except under very special circumstances. There should be nothing in the sewerage arrangements of any school which can bring excreta to a standstill, and keep it for more than a very short time in the neighbourhood of the school buildings. Indeed, from the moment when it passes into the sewer until the moment when it is exposed to those influences which are requisite to alter its chemical form, it should be kept up to the motto which is supposed to belong to the policeman, viz. that of 'moving on.' The sewage should move downward until it is acted upon by some chemical reagent or comes into contact with growing vegetable life, by means of which the organic matter is seized upon and changed into a direction which is quite opposed to the possibility of the establishment of infectious disease. This class of diseases cannot be produced if one of the constituent parts necessary for its production be absent. Changes must take place in a particular direction, in the organic matter of sewage, to allow of the multiplication of disease-producing matter. That direction is associated with fermentative developments. These developments are arrested by chemicals which prevent putrefactive changes, and place the chemical atoms of the compound in a form in which germs of disease cannot grow. But they are more certainly prevented by vegetable life, because the cells upon which plants depend for their growth and development seize upon organic matter with which it comes into contact, and alter its constituent form; so that the fermentative change which is necessary for the increase of zymotic disease cannot take place at all in that matter. Hence, the most perfect preventive service which can possibly be employed against infectious disease is, to bring the matter upon which it depends for its growth and development into contact with vegetable life as soon as possible. The excreta of human beings and of flesh-eating animals are the matters which promote the spread of infectious disease. House sewage should be hurried away from human habitations and brought into contact with vegetable life at the earliest possible moment. Chemicals may destroy the excreta if used in sufficient quantity, but in too many instances they only act as preservers of dangerous matter. They arrest putrefaction, and other allied changes; and in arresting these, they only postpone dangerous changes to some more remote period. This imperfect position cannot arise when vegetable life is the agent, for the organic matter is changed at once into harmless matter, and for ever prevented from giving rise to any kind of danger. Sewage, when once formed, is to be kept in motion until it is far away from any people who are likely to be affected by it, or is brought at once into immediate reach of the

vegetable kingdom. It is in accordance with the law of motion that sewers and house drains require to be ventilated; whenever a trap is inserted in any part of a sewer system, there should be an opening communicating with the outer air close to the trap, and between it and the main sewer. By this means air may be admitted freely into all parts of the sewer system, whether the drain pipes are above or below the level of the ground. No antagonism to this principle should be introduced into any part of the drainage of a school; so that neither air nor sewage may ever have the chance of becoming stagnant even in a short portion of a house drain. The sewers in a given school must be modified according to the character of the district in which it is situated. The water supply of the place will have a considerable influence in determining the principles to be adopted. We must look at them, therefore, from three points of view:—

1. Those districts in which there are neither sewers nor public water supply.

2. Those in which there are both sewers and water supply, and

3. Those districts in which there is a system of sewers with which the school can communicate, but in which there is no public water supply.

Schools situated in districts without either public sewers or water supply have to contend with difficulties which do not belong to town schools. It may be assumed that the district is not a very crowded one, possibly not a very populous one; and if such is the case, it may also be assumed that the inhabitants generally are not very enlightened as to the evils attendant upon bad drainage. It is the custom in the majority of country places to have a cesspool in some retired part of the grounds; it may be a lean-to attached to the least observed side of the school buildings, or it may be situated in one corner of the playground, or even within the precincts of the school itself. All these plans are bad. Cesspools in playgrounds and near to a school-house are full of danger, and are quite certain sooner or later to produce mischief to the children. They will play about the retired parts. When a child is in disgrace, or does not feel well, it will often loiter about the closet for various reasons, at a time when it is most liable to get mischief from the place itself, for disgrace as well as illness produces a depressed state of nerve-power. If there be no water supply, and if it is not possible to arrange for a continuous and abundant quantity, water-closets are not to be thought of; and yet cesspools should not be introduced except in exceptional cases, for the conditions allowing them are very rare. Earth closets such as those constructed by Moser or the Earth Closet Company should be employed. It should be the duty of some person to see that they are kept in a satisfactory state. The school superintendent should himself inspect them every day, and take care that the proper custodian does his duty. I prefer sawdust to earth for the purpose of charging the hoppers; it is cleaner. It is to be obtained in every village by an arrangement with the sawyers of the district; and when it can be obtained from pine-wood, the turpentine in it is itself a deodorizer. If mixed with dry earth, it effects its purpose still better. There is a difficulty with children, because they will play with the hopper—they like to see the action. This can only be obviated by the supervision of the teachers themselves, keeping a strict eye upon the children and frequently inspecting the places. This inspection should be made in the interests of the school. An inculcation of maxims connected with the observances of decency in these places will have a good effect upon the children in more ways than one, and is really an important part of their education, and any superintendent who fails in this duty is neglecting an important branch of a child's instruction.

The urinal is always a trouble at school. It requires to be kept very clean, and to be thoroughly washed down in warm weather every day, and even more frequently if there is infectious disease in the district. Slate is the best material of which to construct it. The floor should be impervious, and York stone or asphalt is to be preferred. It should have a trapped grating communicating with a drain to carry off the water used for washing it down, the trap in the grating being protected by a ventilator. The duty of washing down should be done as naturally as that of sweeping the floor of the school, so that it shall not be possible for the trap to get out of order. A neglect of attention to this principle is certain sooner or later to bring mischief to the children. Enamelled iron is sometimes used, but it is liable to chip; the iron oxidizes, and then it does not keep clean. The slope of the floor should be in a direction away from the person towards the urinal. The slope should be considerable. A slab inclined at an acute angle is frequently put in front to contain water. These slabs are liable to produce nuisance. It is better to have a clear space, so that little boys as well as taller ones may use the place without making a nuisance. There should be a channel cut in the slate a few inches from the wall, about two inches in depth, and that will be sufficient with a proper fall to the outfall or trap. The trap should be outside the place, and out of the way of the boys. It is better for the urinal to be open to the air on all sides, partitions being put up for decency's sake, but so situated that air may blow through and around. If covered, it should be by a roof raised some distance from the walls. The upper part is better enclosed with lattice-work rather than in brick. The closed part should not be much more than breast-high, whilst the lower part should be latticed with brick for about a foot from the ground, so as to allow ventilation in the lower part of the urinal as well as the upper. This is generally neglected, but it is necessary. There are several forms of urinals patented by different makers; but patents are out of place in school premises, and the simpler the apparatus is, the longer it will remain without becoming a nuisance; and, as I have already remarked, a continual supervision and regular cleanliness is necessary for every kind of urinal and closet. I prefer this plan to any other. If there is a water supply provided, and water is allowed to trickle down from a pin-holed pipe, children will play with the streams and try to drink from the holes. Everything likely to detain children in these places should be interdicted. Personal inspection and frequent washing by persons appointed to do it are far better than the elaborate apparatus which is often provided for the purpose of avoiding this duty. The most elaborate system requires about as much supervision as the simple one I advocate, whilst elaborate designs are also expensive. Wood-work of all kinds should be kept out of the

place, at least out of the reach of contamination. If York paving is employed, large slabs should be used, and the use of metal avoided except where absolutely necessary. Places for five persons for each hundred should be provided in the case of day-schools, whilst for boarding-schools the number should be increased to six or seven. The character of the closet must depend upon circumstances. There ought to be eight provided for each hundred children in boarding-schools, and girls require rather larger allowance than the boys, because in the case of the former urinals are not required. The arrangements provided by Moser in his form of closet meets a serious difficulty. There is a partition in the soil-pan which separates the solids from the liquids; and if these are properly looked after, they do admirably well, but like everything else connected with sewerage arrangements, they require a continuous supervision. If there is a good nuisance inspector, as there ought to be in every district, it is wise to make an arrangement with that official to visit the premises frequently, and see that the instructions of the manager are carried out. As regards the soil which has been used in the closets, there ought not to be any difficulty in arranging with some neighbouring gardener to remove it, replacing the tub which has been used by an empty one. It is necessary to arrange that the visit for this purpose should be when the places are not likely to be in use. Early in the morning before the children are moving is the best time for the purpose.

Some authorities upon school hygiene suggest that children should not be expected to go out into the open air for natural purposes connected with the use of the closet or urinal. It may be wise sometimes to provide for a covered way from the class-rooms to the W.-C's, but I strongly object to closed passages, even when swing doors are provided. These passages are certain to convey foul air into the house, and the swing doors act directly as pumps for bringing it into the class-rooms. Delicate children who cannot bear the exposure which arises in passing from the school to the outbuilding, are much more likely to be injuriously affected by the foul air of a badly constructed closet than by the exposure which arises from going out of doors for such a purpose. Children who are brought up in properly ventilated schools, are not likely to receive damage from this exposure. If there is a system of sewers into which the sewage of the school can pass, the most convenient form of drainage is by means of the water-closet. The vessel should always be constructed of earthenware, and those in which the flush of water is considerable, and which are without so-called containers, are best. The pan should be so fixed that the flush of water shall wash away the contents directly into the drain, and not drop them down into an abyss below, there to remain until another visitor comes to the place. In this latter form of closet, there is always foul air rising from the container every time the closet is used. The soil pipe attached to each closet should be properly ventilated by a pipe equal in diameter to the soil pipe; this should pass directly upwards, and be open above the level of the school buildings. This ventilator must be between the sewer and the trap of the closet. The forms of closets are very various. I have mentioned the best principle to be adopted: the flush of water should be immediate and full, not a driblet, as is too often the case. Care should be taken that the fittings connected with the water supply are made of substantial iron, and so placed as not to become frozen in long cold seasons. If they run any risk from this source, they should be encased in felt, and an arrangement made either for keeping them empty at night, or for heating the iron so that freezing shall be impossible. In some large schools a kind of trough closet is provided, allowing of use by several together, and making one flushing operation for perhaps fifty visitors. It is flushed out at regular intervals by an attendant. I think the plan is a bad one, and only to be allowed under very special circumstances. Closets which flush themselves by an action caused by the weight of the user are advantageous when well constructed, but they are very liable to get out of order and lead to expense.

The requirements of a school as regards water will not be less than eight gallons per head per day for water-closet purposes. The greatest care must be taken that the water stored for the purpose of flushing the closets shall not be drunk by the children. An ample supply of water for drinking purposes should always be provided in every school, but it should not be taken from a cistern which is kept over a closet. Pure water is very absorbing, and the gases which naturally belong to a W.-C. which is in frequent use are rapidly absorbed by the water. If this is drunk, it may be a means for spreading disease. Water for drinking purposes should, if stored at all, be stored in a cistern which has no connection with the water-closet. There should be a water supply easy of access in every playground, and yet so placed as not to be capable of being made into a means of mischievous play. It should be inculcated as a moral duty that water must be kept pure, and that to pollute the water, or to play with it, will be considered as a serious offence. If there is no public water supply, there will be much difficulty in meeting this want; but it is really important that children should be provided in some way or other with pure water, and that thus the risk should be diminished which arises from their being tempted to quench their thirst at some pond or road-side ditch. A school without a supply of water for drinking purposes fails in a part of its work. A thirsty child is not in the best condition to receive instruction, and a draught of pure water before going into school may make all the difference as regards the completion of the work, and between the exhibition of temper or of amiability. I urge all managers of schools to take care that a water supply is easy of access for the scholars, and that they have time and opportunity to take advantage of it.

Anecdotal Natural History.

No. IV.—THE MOLE.

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ONE of the most useful, and, at the same time, one of the least appreciated of the whole animal creation, is found in the Mole (*Talpa Europæa*),

which, in spite of the inestimable benefit it confers upon agriculturists, is ranked by them as one of their worst enemies, and persecuted accordingly.

We can hardly pass through a meadow in many parts of the country without noticing a number of upright sticks planted in various parts of the field, to every one of which is suspended a mole which has been captured and slain by one of the professional trappers employed by the farmer. Now, if the farmer had taken the trouble to look below the surface, and traced the mole through its day's work, he would have found that, instead of damaging his fields and ruining his crops, the animal was in reality rendering him services which could hardly be procured for money, and that instead of untiring persecution and ruthless extermination, it ought to be protected and encouraged to the utmost of his power.

But, as with many other almost equally useful creatures, so it is with the mole, which, placed in the category of 'vermin,' falls under the ban of the farmer, and pays with its life the penalty of human ignorance.

To us who inhabit the upper world, it seems a

Common Mole, and White or Albino Variety.

strange and comfortless life this of the mole, spent in its cold, dark tunnels beneath the earth. We can hardly conceive a more wretched existence than one passed in an underground dungeon, damp and cold, and never cheered by a ray of sunlight. Yet our pity would be wasted were we to bestow it upon the mole, for no animal is better suited to its own mode of life, or more carefully adapted to obtain enjoyment from its apparently unpleasant surroundings.

Indeed, the mole is quite as unhappy when taken from the darkness, damp, and cold where it lives, as we should if placed in a subterranean dungeon and deprived of the light, dryness, and warmth which are essential to our comfort.

In every detail of its structure, we see how well the mole is suited to the life it has to lead. Cylindrical in form, its pointed snout and powerful digging-claws enable it to burrow through the soil with wonderful rapidity, while every sense is modified to suit the circumstances of its existence.

Like those of all the rest of the *Insectivora*, or insect-devouring animals, to which group it belongs, the teeth of the mole are formed for biting and seizing prey alone, and not for masticating the food, a few sharp pecking bites being the only preparation for swallowing it. It is by this structure of the teeth, also, that these animals are enabled to grasp and retain the struggling prey.

In order to fit the mole for its burrowing life, the strength of the fore-parts is developed to a wonderful degree.

The bones of the fore-limbs are stout, ridged, and considerably bowed, always a sign of great strength. The shoulder-blade, in particular, is of extraordinary length, in comparison with those of other animals, even that of the tiger or lion, either of which creatures can strike an ox to the ground with a single blow of its paw, fading into comparative insignificance beside it. In fact, if the mole were enlarged to the size of the tiger, it would be by far the stronger and more terrible animal of the two.

This extra length of shoulder-blade is necessary for the attachment of the large and powerful muscles which work the fore-limbs, and which, when the skin is stripped off, can be seen lying in thick masses, almost as hard and strong as so much steel wire.

With this wonderful development of muscular power, it is no wonder that the burrowing powers of the mole should be so great, seeing, besides, what efficient digging instruments it possesses in its fore-paws. These are set obliquely with the body, in order to secure a larger scope for their movements. They are large and powerful, not covered with fur like the rest of the body, and are furnished with long, curved, and rather flattened claws, which can penetrate the hardest earth.

These paws occasionally fulfil other offices than those of digging, for the mole is by no means a bad swimmer, and is often known to cross brooks and small streams, using the paws as paddles.

It is scarcely possible to select two creatures which present stronger contrasts to each other in point of structure than the moles and the bats, both insectivorous, but the one formed for flying in the air, and the other for burrowing in the ground.

In both animals the hind-limbs are but little required, and therefore they are feeble and comparatively insignificant, the chief distinction being in the development of the fore-limbs.

Beginning with the shoulder-blade, or 'scapula,' we find it large in both animals, but differently developed, in the bats being wide, thin, and covering many of the ribs, reaching as far as the pelvis.

In the mole, the scapula is long, narrow, very strong, and projecting upwards so as to afford attachment for the powerful muscles of the arm. The other bones are shortened and thickened in order to carry the enormous digging claws, and are deeply ridged for the attachment of the tendons which work the joints. In the bats they are attenuated to the last degree, and only one of them is capable of bearing a slight, hooked claw, solely employed for dragging itself clumsily over a level surface.

Yet the bones are the same in each case, and when the creature is dissected, the exquisitely perfect adaptation of each bone to its own office cannot but excite our highest wonder and admiration.

In the accompanying illustration the skeleton of the fore-limbs is given, so that the reader may compare the bones with those of the bat, which have already been described and figured.

The structure of the long and flexible snout is well calculated to aid the mole both in digging and also in ascertaining the nature of the soil in the places which it selects for its burrows; for, though

Common Mole. Bones of Fore-limbs.

sensitive and possessing a keen sense of touch, it is of great service in shovelling out the loosened earth—a task for which it is further suited in some species by the possession of a small auxiliary bone in the tip. This auxiliary bone is also found in the snout of the pig, which in its wild state procures a considerable portion of its food by means of the digging powers of that member.

While the animal is living, the snout is of a pinkish colour, and of a very elastic nature; it is a curious fact that, after death, it becomes hard and wrinkled, and not even the most experienced taxidermist can restore it to its pristine appearance.

Even the fur of the mole is arranged in such a manner as not to impede its progress while passing either backwards or forwards along its burrow. In order to attain this result, each hair is finest nearest the body, gradually increasing in thickness towards the tip, and is set perfectly upright, in order that its resistance may not impede the animal in its movements.

When washed perfectly clean, and viewed in a good light, the fur is seen to be beautifully iridescent, all the colours of the rainbow playing over it in succession. This is still more strongly the case in the changeable mole of South Africa (*Chrysochloris holosericea*), which will be presently mentioned.

Attempts have been made to put the skin of the mole to various uses, only one of which, however, seems to have met with any particular success. This solitary instance is in the manufacture of purses, a custom much in vogue among the peasantry in some parts of the country. The operation is simplicity itself, the head and legs of the animal being taken off, the skin of the rest of the body dried, and the bag thus formed being closed by a string round the neck. In Wiltshire these purses are in very common use. From the great warmth of the fur of the mole, it has often been thought that it might be utilized in the manufacture of garments; and the late Mr. Frank Buckland, always fond of trying experiments in anything relating to natural history, procured a number of the skins, and had a waistcoat made from them.

However, he was never able to wear it, for two reasons—the first being that it was even *too* warm, so much so as to be almost unendurable; and the second, that it was impossible to get rid of the unpleasant odour which characterizes the mole, and which persistently clung to the skins for years after they had been separated from the bodies of their owners.

So strong is this odour, and so long does it retain its power after the death of the animal, that the professional mole-catchers are accustomed, before setting each trap, to rub their hands with the body of one of their victims, which they carry with them for that purpose, in order that the wary animals may not detect the human scent about the trap, and be warned of its danger accordingly.

With the single exception of sight, the senses of the mole are developed to a very considerable extent.

Its hearing is proverbially acute. For instance, in Shakespeare's play of *The Tempest*, the deformed slave Caliban advises his friends, when they are about to rob Prospero: 'Pray you, tread softly, that the blind mole may not hear a footfall,'—a phrase which has since become almost a household word.

It is not to be supposed that this sharpness of hearing is entirely owing to the delicate structure of the mole's ear; for if it were to live in the open air, it is doubtful whether it would be able to hear better than any other animal. The fact is, that the earth is a very good conductor of sound, as may be easily proved by laying the ear upon the surface of a high road, when the noise of an approaching carriage may be distinctly heard while it is yet two or three miles distant.

Here, again, we have an instance in Shakespeare. In *Romeo and Juliet*, Act v. Scene iii., occur the lines:

> 'Under yon yew-tree lay thee all along,
> Holding thine ear close to the hollow ground;
> So shall no foot upon the churchyard tread,
> Being loose, unfirm, with digging up of graves,
> But thou shalt hear it.'

The sense, too, of scent is particularly strong, enabling the mole to detect the presence of the insects and worms upon which it preys.

The sense of touch, also, is highly developed, more especially in the snout, which the animal uses to examine the nature of the soil into which it intends to burrow. If a mole on the surface of the ground wishes to sink a fresh tunnel, it may often be seen running to and fro, and trying various places with the snout, until it has settled upon one to its liking.

Although the senses of scent, touch, and hearing are so extremely sensitive, that of sight is little more than rudimentary. On casually examining a mole, the observer would be unable to detect the presence of eyes, which are deeply buried in the fur, whence, however, they can be protruded at the will of the owner. The creature can be forced to expose them by suddenly dipping it into a pail of water, when the mole, alarmed at the unexpected immersion, instinctively protrudes them from the mass of fur with which they are usually covered, looking like very small black beads. Even when thus exposed, the vision is very imperfect, and is, indeed, hardly necessary in the subterranean existence which the animal leads.

The FOOD of the mole consists chiefly of worms, grubs, and other small creatures which it finds beneath the surface of the earth. By the mere destruction of the dreaded 'wireworm' grubs, and the larvæ of the common cockchafer, which so often devastate the crops, it renders no small service to the farmer, and this alone should protect it from the persecution to which it is so constantly subjected.

Although it finds the greater part of its food in these creatures, it by no means despises prey of a larger nature, and will eagerly devour any small bird or mouse which it may happen to meet with.

Its voracity is something extraordinary; for if kept as a pet, it is one man's work to keep it supplied with worms. It is almost impossible to describe the ferocity with which it devours its prey.

As soon as a worm is put into the cage, it detects the presence of food as if by magic, springs upon its victim, and rapidly forces it into its mouth with the fore-paws, giving meanwhile a series of rapid crunching bites, and causing the unfortunate worm to disappear with marvellous celerity.

No sooner is the first worm swallowed than it is on the look-out for a second, which is speedily disposed of in a like manner. So voracious is its appetite, that it is said to be unable to endure a fast of more than three hours. Among the peasantry it is commonly reported that the animal alternately works for three hours and sleeps for three hours, and this seems very likely to be the case.

The mole seems to suffer greatly from thirst, and always digs a series of wells in different parts of his burrows, to which he can repair when in need of moisture.

The passions of the mole are all of the fiercest nature, and when enraged, it seems utterly devoid of fear, attacking an enemy far superior in size to itself, and fighting with the greatest ferocity until death puts an end to the scene. One mole was even known to turn upon the individual who was holding it, and inflict a severe wound, refusing to quit its hold until almost killed by the teeth of its victim, no other means proving of avail.

If, by any chance, two strange moles should happen to meet in a burrow, there is but one invariable termination to their encounter. They fight, and the conqueror devours its vanquished foe.

The rather unsightly although useful 'molehills,' which are so plentiful in many places, serve to show the course which has been followed by the mole, the hillocks being merely the superabundant earth which it is obliged to throw out at short intervals. These tunnels mostly terminate in the 'fortress,' as it is termed, which is a really fine specimen of excavation, almost attaining the rank of architecture.

The situation selected is generally at the roots of a tree or large bush, where the ground is unlikely to give way above it.

The general plan of the structure is as follows:—

In the centre is a rather large circular chamber with exits at various places, which lead into a gallery surrounding it. Above this is a second circular gallery, communicating with the lower one by no less than five passages.

A large passage opening into the high road, is driven down from the lower gallery, and a large series of tunnels, radiating on all sides, and all communicating with the lower gallery, are finally constructed.

It will thus be seen that the mole, if chased by an enemy able to follow it along the tunnels, can take refuge in the fortress, pass through the centre chamber, and escape by one of the passages on the opposite side, leaving its foe bewildered in the complicated maze of tunnels. The reader must not, however, think that every fortress contains the whole of these passages and galleries; and, indeed, it is very doubtful whether any individual fortress contains both circular galleries and all the connecting passages.

The central cavity is usually filled with a quantity of moss, dead leaves, grass, etc., and is used as a bed-chamber by the mole during the colder seasons of the year. In warmer weather, however, it generally takes up its abode in one of the ordinary hillocks.

Generally at some little distance from the fortress, the female mole constructs her nest, which she builds in some large hillock, and lines with moss or dried grass. In this she brings up her young, usually from four to six in number, and provides for them until they are able to take care of themselves. Some good examples of the mole's nest may be seen in the museum at Liverpool.

The colour of the mole is usually of a blackish grey, somewhat paler upon the under side, although it varies to a considerable extent. Some specimens have been found of a pure white, and pale varieties are by no means uncommonly taken.

Putting on one side the immense benefit conferred upon the farmer by the wholesale destruction of 'wireworms,' the larvæ of the cockchafer and daddy-long-legs, which, feeding upon the roots of the crops, cause wholesale devastation, the mole is of the greatest service to the agriculturist in more ways than one.

His complicated network of subterranean passages, daily and hourly extended, not only forms a nearly perfect system of subsoil drainage, which could with difficulty be equalled by human labour, but the fresh earth brought continually to the surface from a considerable depth below the reach of the plough or spade, acts almost like manure in increasing the fertility of the land, and renders it capable of nourishing the crops with which it is planted. All that is necessary in a mole-inhabited meadow is to apply a rake to the heaps of earth, and spread them evenly over all parts of the field, in order that every yard shall receive its due share.

In yet another way does the mole prove himself the friend of the farmer, for by means of the loosened earth the air is enabled to reach the roots of the plants, where it is so much needed, and where it would have little chance of reaching were it not for the beneficent and untiring labours of the mole.

With such claims upon the farmer, it seems strange that the habits of the animal should be so little understood and appreciated, and we can only hope for the time when the spread of zoological knowledge shall have shown that both this, and many others of the so-called 'vermin,' instead of being persecuted, should be protected and encouraged to the utmost of our power.

TURNING to foreign countries, we find several very near relations of our common mole, some of which present very great peculiarities both in habits and form. One of the most remarkable of these animals is the Chrysochlore, Shining Mole, or Changeable Mole (*Chrysochloris holosericea*), found chiefly in the Cape of Good Hope. As before mentioned, the fur of this creature possesses a brilliant metallic radiance, changing in various lights, and far superior to that of our British example, beautiful though that is. The scientific title is singularly appropriate, the name *Chrysochloris* being formed from two Greek words signifying gold-green; and *holosericea*, *i.e.* wholly silken, referring to the texture of the hairs.

In other ways, also, the Chrysochlore is worthy of notice. The digging paws are formed after a very singular fashion, being provided with four toes, the last of which is but of small size. The remaining three, however, are furnished with very long and powerful claws, the middle one especially being of surprising dimensions.

The jaws of this species are constructed after a perfectly unique fashion, a gap equal to the width of a tooth being left between each; so that when the jaws are closed, the teeth of each jaw fit into the interstices of the opposite one like those of a steel trap.

In the skeleton, also, are found several peculiarities, one being that there are no less than nineteen pairs of ribs. The tail is entirely wanting.

Another of the foreign moles, and one of a very extraordinary appearance, is the Radiated or Star-nosed Mole (*Astromyces cristatus*), sometimes known as the Condylure, which is found in Canada and the United States.

Snout of Condylure.

In this animal the tip of the snout is modified into a number of pink, fleshy rays, branching off in every direction, and sometimes being as many as twenty in number. These rays are retractile at will, and are supposed to aid the animal in its delicate sense of touch, and in procuring the worms, etc., on which it feeds. Another curious point about the Condylure is the size of its tail, which sometimes exceeds two and a half inches in length. The name Condylure is formed from two Greek words, the former signifying a knob and the other a tail. It was given to the animal by a person who had only seen the dry skin and not the living creature. Except for its great comparative length, the tail has little about it that is remarkable. But, when the animal is dead, the skin contracts so forcibly over the vertebræ of the tail, that the organ looks something like a row of roundish beads strung upon wire and covered with skin.

Short Historical Anecdotes.

BY REV. SIR GEORGE W. COX, BART., M.A.

(21) St. Louis of France.

Few biographies are more full of interest than the *Memoirs of Louis the Ninth of France*, better known as St. Louis, by Joinville. They bring before us a complete picture of the man in his gentleness and his firmness, in his humility and his sturdy self-respect, in his strength and in his weakness; and of the many stories which he relates about him, not a few are singularly characteristic both of Louis himself and of the age in which he lived. In one of these tales he speaks of a woman who, pleading her cause before him, burst out into the exclamation: 'You are not a king of France; you are a king only of priests and monks. It is a pity that you are king of France. You ought to be turned out.' 'You speak truly,' answered Louis; 'it has pleased God to make me king. It would have been well had He chosen some one better able to govern this kingdom rightly.' The woman was sent away with a gift of money.

(22) St. Louis—Methods of Controversy.

In matters of religion St. Louis would not hear of doubt, questioning, or argument. In his belief there could, under no circumstances, be need of any. He dwelt, Joinville tells us, with hearty approval on the conduct of a knight who, during a controversy between some Jews and the monks of the Abbey of Clugny, asked leave of the abbot to say a few words. With some difficulty he obtained the abbot's consent. Then, raising himself on his crutches, the old warrior beckoned the rabbi to draw near, and put to him one question: 'Do you believe in the Virgin Mary who bore our Saviour Jesus Christ, and that she was a virgin when she was the mother of God?' The Jew answered promptly that he believed not one word of it. 'Fool that thou art,' replied the knight, 'for daring to enter a Christian monastery when thou disbelievest these things. For this madness thou shalt now pay.' Lifting up his crutch, he struck the man a blow on the ear which felled him to the ground. His comrades fled away from the scene of controversy, while the abbot, coming forward, reproved the knight for his folly. 'Thou art the greater fool,' was the knight's answer, 'in permitting an assembly from which good Christians might, by listening to their arguments, have gone away unbelievers.' The king, Joinville adds, pointed the moral of the story by saying, 'No one, however learned or perfect a theologian he may be, ought to dispute with Jews. The layman, whenever he hears the Christian faith impugned, should defend it with a sharpened sword, which he should drive up to the hilt into the bodies of the unbelievers.'

(23) Crusade of St. Louis—Teaching by Signs.

Joinville, in his *Memoirs of St. Louis*, tells us of a woman who, in the crusade headed by that king, was seen carrying in her right hand a porringer of fire, and in her left a bottle of water. With the fire, Joinville says, she wished to burn paradise, with the water to drown hell, so that none might do good for the reward of the one, nor avoid evil from fear of the other, since every good ought to be done from the perfect and sincere love which man owes to his Creator, who is the supreme good.

(24) Boabdil of Granada and Ferdinand of Castile.

The conquest of Spain was one of the greatest and most abiding achievements of the followers of Mahomet. Not much more than four centuries have passed since the Turkish Sultan won Constantinople from the last Emperor of the East. The dominion of the Saracens in Spain lasted for nearly eight hundred years. It began with the victories of Taric ben Zeyad, who has given his name to Gibeltaric, Taric's rock, Gibraltar. The story is a tale of terrible treachery (if the legends of Count Julian have any elements of truth), as well as of awful bloodshed; but the humiliation of Roderick, the last of the Gothic kings in Spain, was almost paralleled by that of Abu Abdullah, or Boabdil, the last of the Moorish Sovereigns of Granada. That beautiful city was surrendered to Ferdinand and Isabella of Castile on

the feast of Epiphany, the day of kings, in the year 1492. Early in the morning the king and queen set out at the head of a splendid train from the city of Santa Fé (holy faith), which they had built to serve as a blockading camp during the siege. Hearing the sound of the drums which announced their approach, Boabdil rode forth from his capital, and on coming within speaking distance of the Spanish king made a movement as if he would dismount from his horse; but this Ferdinand would not allow, and Boabdil, kissing his right arm, declared himself his subject. Later Moorish legends multiplied tales not altogether to the credit of the king, who had won for himself the name of El Zogoybi, the unlucky. One of these recorded his entreaty to the Castilian prince that no one should be allowed to pass through the gate by which he had left the city before he made the surrender, and that accordingly it was by Ferdinand's order walled up. Another related how, as he approached the spot from which the last view might be seen of the town of Granada, and which is now known as the Last Sigh of the Moor (*el ultimo sospiro del Moro*), Boabdil burst into tears; and how his mother, whose wisdom and resolution had during the whole of his reign been the chief support of his tottering power, exclaimed, 'Thou doest well to weep as a woman over what thou couldst not defend as a man.' Boabdil soon crossed into Africa, and there the prince, who had not found courage to die in defence of his own country and kingdom, fell, it is said, in the attempt to beat off the enemies of the sovereign who had given him a home after his expulsion from Spain.

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'How I teach Arithmetic.'

(*Continued from page* 122.)

BY WILLIAM SPENCER,

Author of 'Spencer's Exercises in Arithmetic.'

(*f*) Division of fractions naturally follows multiplication, and the principle of the operation may be comprehended by the scholars if carefully explained. Example:—Divide $\frac{3}{4}$ by $\frac{2}{5}$. A little oral questioning and explanation would draw from the children what is really required. How many times is $\frac{2}{5}$ contained in $\frac{3}{4}$? Suppose we take a shilling, then $\frac{3}{4}$ of it is 9d., and $\frac{2}{5}$ of it (1s.) is 8d., and the latter is contained in the former $1\frac{1}{8}$ times. In working the exercise on the board we might first, as in addition and subtraction, bring the fractions to a common denominator—$\frac{9}{12}$ and $\frac{8}{12}$, then as they are the same kind of parts (12ths), we can divide the 9 by the $8 = 1\frac{1}{8}$. Again, show that $\frac{3}{5}$ besides being considered as 2 parts out of the 3 into which the integer (unit) is supposed to be divided, it may also be considered as 2 divided by 3, $\frac{4}{5}$ as 4 divided by 5, $\frac{5}{8}$ as $5 \div 8$, etc.; so that these three expressions—divide $6\frac{1}{2}$ by $2\frac{3}{4}$, $6\frac{1}{2} \div 2\frac{3}{4}$, and $\frac{6\frac{1}{2}}{2\frac{3}{4}}$, all denote the same operation. Now $\frac{3}{4} \div \frac{2}{3}$ means that $\frac{3}{4}$ is to be divided by the third part of 2. To divide a fraction by any integer (as 2), we multiply the *denominator* by that figure, thus virtually making the parts half the previous size, hence $\frac{3}{4} \times 2 = \frac{3}{8}$; but $\frac{3}{4}$ was only to be divided by the *third* part of 2—not by 2; then as we have divided by three times as much as is required, we must now multiply the result obtained by 3,—then $\frac{3}{8} \times 3 = \frac{9}{8} = 1\frac{1}{8}$, the same result as before. Let us now retrace our steps and see what operations we have performed on the $\frac{3}{4}$. First, we multiplied the denominator (4) by the numerator (2) of the divisor, and then we multiplied the numerator of the result obtained ($\frac{3}{8}$) by 3; that is, when expressed as one operation—$\frac{3}{4} \times 2 \times 3 = \frac{9}{8} = 1\frac{1}{8}$—we virtually *invert the divisor and proceed as in multiplication.*

(*g*) Now, if not at a previous stage, reduce fractions to their lowest terms or simplest form. We would here remark that the various stages in working fractions given above, or those to follow, need not necessarily follow in any exact determinate order; but we are following somewhat the order in which *we* generally take them. Let the scholars clearly see what 'lowest terms' really means—simplest form of representation. Show that $\frac{20}{40}$, $\frac{10}{20}$, $\frac{5}{10}$, and $\frac{1}{2}$ all denote the same fractional part, and that $\frac{1}{2}$ is the simplest form. A little intuitive inspection of the numerator and denominator will often, perhaps generally, suffice—especially when the number of figures is only small—to reduce a fraction at once, or by successive steps, to its lowest terms. Thus $\frac{24}{36} = \frac{2}{3}$, the two numbers being divisible by 12; $\frac{35}{70}$ (5) $= \frac{11}{14}$, $\frac{132}{180}$ (12) $= \frac{11}{15}$, $\frac{168}{224} = \frac{42}{56} = \frac{6}{8} = \frac{3}{4}$. We now take the formal method of finding the Greatest Common Measure—G. C. M. as it is generally expressed, the theory of which, however, we shall waive, at least for the present, as it is somewhat difficult to make simple, except algebraically. From the exercise worked out below, the children will notice that the greater number is simply divided by the lesser one, and each divisor by its succeeding remainder till no remainder is left; the last divisor (48) being the G. C. M. Bring $\frac{1296}{1536}$ to its lowest terms:—

$$1296\overline{)1536}(1 \quad 1296$$

$$240\overline{)1296}(5 \quad 1200$$

$$96\overline{)240}(2 \quad 192$$

$$48\overline{)96}(2 \quad \underline{96}$$

Then dividing the numerator and denominator each by 48, we have $\frac{1296}{1536} = \frac{27}{32}$. Ans.

N.B.—The above, and a few previous exercises, are worked out chiefly as aids to those who may be studying arithmetic without the help of a teacher.

(*h*) Simplify *complex* fractions. These were slightly touched upon in working the exercises in Compound Practice, but require further comments. Explain that the word is the opposite of simple—difficult, intricate, and that to work such fractions they must first be simplified. They may be defined as fractions that have a fractional part in their numerator or denominator, or in both—$\frac{3\frac{1}{4}}{8}$, $\frac{7}{9\frac{1}{2}}$, $\frac{6\frac{2}{3}}{10\frac{7}{12}}$. Explain clearly what each of these fractions denotes,—that the first means $3\frac{1}{4}$ parts out of 8, that is, bringing both to fourths, 13 out of 32,—thus $\frac{3\frac{1}{4}}{8} = \frac{13}{32}$. The third denotes $6\frac{2}{3}$ parts of $10\frac{7}{12}$, or bringing the $\frac{2}{3}$ to 12ths, $6\frac{8}{12}$ out $10\frac{7}{12}$;

then bringing both numbers to twelfths, 80 out of 127; —expressed methodically thus: $\frac{6\frac{8}{12}}{10\frac{7}{12}} = \frac{6\frac{8}{12}}{10\frac{7}{12}} = \frac{80}{127}$.

Another, *e.g.*, $\frac{8\frac{3}{8}}{11\frac{6}{13}} = \frac{8\frac{9}{24}}{11\frac{10}{24}} = \frac{201}{274}$.

Under each of these heads as we proceed, a number of *short* exercises should be dictated or worked on slates from the board, first requiring simply the operation we have just explained, and then also one or more of the operations previously given. Example: $\frac{3}{8} + 4\frac{3}{8} + \frac{3}{4}$ of $\frac{5}{8} + \frac{3}{4}$ of $2\frac{1}{2}$. First simplifying the two compound fractions, we have $\frac{3}{4}$ of $\frac{5}{2\,8} = \frac{5}{8}$, and $(\frac{3}{4}$ of $2\frac{1}{2}) = (\frac{3}{4}$ of $\frac{5}{2}) = 1\frac{5}{8} = 1\frac{7}{8}$. Then we have $\frac{3}{8} + 4\frac{3}{8} + \frac{5}{8} + 1\frac{7}{8}$, in which the fractions $= \frac{33}{120} = 2\frac{92}{120} = 2\frac{23}{30}$, to which add the 5 (4 + 1) and we have $7\frac{23}{30}$. Another example:—Add together $\frac{1}{8}$ of $6\frac{3}{8}$ and $\frac{2\frac{1}{2}}{4\frac{3}{5}}$, then divide the sum by $\frac{2}{3}$ of $2\frac{3}{10}$. We will work this exercise out fully and more formally:—

$\frac{1}{5}$ of $\frac{5\,1}{2\,8} = \frac{51}{10} = 5\frac{1}{10} = 5\frac{23}{230}$

$\frac{2\frac{1}{2}}{4\frac{3}{5}} = \frac{2\frac{5}{10}}{4\frac{6}{10}} = \frac{25}{46} = 0\frac{125}{230}$

$5\frac{148}{230} = 5\frac{74}{115}$, Sum.

$\frac{2}{3}$ of $5\frac{23}{10} = \frac{23}{15}$, Divisor. $5\frac{74}{115} = \frac{649}{115}$.

Then $(\frac{649}{115} \div \frac{23}{15}) = \left(\frac{649}{\cancel{115}} \times \frac{\overset{3}{\cancel{15}}}{23}\right) = \frac{1947}{529} = 3\frac{360}{529}$. Ans.

We will now proceed to further elementary operations. (*i*) How much is $\frac{5}{9}$ of £? Here we simply bring the £ to shillings and pence by multiplying,—$\frac{5}{9} \times \frac{20}{1} = \frac{100}{9}$s. $= 11\frac{1}{9}$s. $= 11$s. $1\frac{1}{9}$d. Bring $\frac{7}{12}$ ton to cwts. qrs. etc. $\frac{7}{12} \times \frac{20}{1} = \frac{140}{12} = 11\frac{8}{12} = 11\frac{2}{3}$ cwt. $= 11$ cwts. $2\frac{3}{7}$ qrs. $= 11$ cwts. 2 qrs. $18\frac{3}{7}$ lbs. $= 11$ cwts. 2 qrs. 18 lbs. $10\frac{2}{7}$ oz. Ans.

(*j*) Bring 3s. $3\frac{3}{4}$d. to the fraction of a £;—bringing both to farthings we have 3s. $3\frac{3}{4}$d. $= 159$, and a £ $= 960$, hence the former is of the latter $\frac{159}{960} = \frac{53}{320}$. Ans. Bring 2 days 13 hours 40 minutes to the fraction of a week;—first bring both to periods of 20 minutes or thirds of an hour.

days	hrs.	min.		days
2	13	40		7
24				24
61				168
3				3
185				504

Hence the fraction is $\frac{185}{504}$. Ans.

(*k*) Bring $\frac{3}{8}$ of a shilling to the fraction of a £. We can work this exercise by method (1) by finding that $\frac{3}{8}$s. $= 4\frac{1}{2}$d., and then bringing it to the fraction of a £,—$\frac{4\frac{1}{2}}{240} = \frac{9}{480} = \frac{3}{160}$. Ans; (2) the shorter method, as a *whole* shilling is $\frac{1}{20}$ of a £, then $\frac{3}{8}$s. is $\frac{3}{8}$ of $\frac{1}{20} = \frac{3}{160}$. Ans. What fraction of a guinea is $\frac{1}{7}$ crown? By second method, as a whole crown is $\frac{5}{21}$ of a guinea, then $\frac{1}{7}$ is $\frac{1}{7}$ of $\frac{5}{21} = \frac{20}{147}$ guinea. Ans. Bring $\frac{2}{3}$ yard to fraction of a foot. Here we simply multiply by 3 to get yards to feet, then $\frac{2}{3} \times \frac{3}{1} = \frac{2}{1}$ foot. In bringing a fraction of one denomination to the fraction of another, show that we really proceed in the same manner as if they were whole numbers; thus to bring inches to feet we divide by 12, hence to bring a fraction of an inch to the fraction of a foot, we divide by 12,—$\frac{3}{8}$ inch $\div 12 = \frac{3}{8} \times \frac{1}{12} = \frac{3}{96} = \frac{1}{32}$ foot. To bring feet to inches we multiply,—$\frac{1}{20}$ foot $\times 12 = \frac{1}{20} \times \frac{12}{1} = \frac{12}{20} = \frac{3}{5}$ inch.

(*l*) What fraction of $\frac{7}{8}$ is $\frac{3}{5}$? or, $\frac{3}{5}$ is what fraction of $\frac{7}{8}$? Here we are bringing *one fraction to the fraction of another*. Bringing both to the same denominator, we have $\frac{3}{5} = \frac{24}{40}$ and $\frac{7}{8} = \frac{35}{40}$; hence the result is $\frac{24}{35}$, as the 16 and the 21 are the same kind of parts—24ths, $\frac{7}{12}$ is what fraction of $\frac{7}{9}$? Here $\frac{7}{12} = \frac{21}{36}$ and $\frac{7}{9} = \frac{28}{36}$, hence we have $\frac{21}{28} = \frac{3}{4}$. $3\frac{5}{8}$ is what fraction of $6\frac{2}{5}$? Here we only express as a fraction and simplify,—$\frac{3\frac{5}{8}}{6\frac{2}{5}} = \frac{3\frac{25}{80}}{6\frac{12}{30}} = \frac{115}{192}$.

(*m*) Bring $\frac{7}{12}$ to a *fraction whose denominator* is 60. Here $\frac{1}{12}$ is $\frac{5}{60}$, hence $\frac{7}{12} = \frac{35}{60}$; or, as the denominator (12) requires multiplying by 5 to give the new denominator (60), we multiply the numerator (7) by the same number (5), and we have $\frac{35}{60}$. Bring $\frac{3}{8}$ to a fraction whose denominator is 42. Here $42 \div 5 = 8\frac{2}{5}$, that is, the denominator of the given fraction requires multiplying by $8\frac{2}{5}$ to give 42, hence the numerator (3) must also be multiplied by $8\frac{2}{5}$ ($8\frac{2}{5} \times 3 = 25\frac{1}{5}$), hence the result $\frac{25\frac{1}{5}}{42}$. Impress well that multiplying the numerator and the denominator by the same number does not affect the *size* of the fraction, being still the same. We will now simplify the fraction obtained, and thus prove it to be correct,—$\frac{25\frac{1}{5}}{42} = \frac{126}{210} = \frac{3}{5}$, as 42 will divide them. Bring $\frac{11}{16}$ to a fraction whose *numerator* is $24\frac{1}{2}$. Here elevens in $24\frac{1}{2} = 2\frac{5}{22}$, which, multiplied by $16 = 35\frac{14}{22} = 35\frac{7}{11}$, hence the result is $\frac{24\frac{1}{2}}{35\frac{7}{11}}$, which simplified $= \frac{24\frac{11}{22}}{35\frac{14}{22}} = \frac{539}{784} = \frac{77}{112} = \frac{11}{16}$, the fraction we began with. In order to impart a concreteness and reality in teaching fractions, as well as a familiarity and expeditiousness in treating them, at every stage I give a large number of short exercises to be worked mentally, having the board in front of the class—as indeed for every lesson of whatever kind—for any special explanation when required. The following is a verbatim copy of two such lessons given this day (April 6)—(*a*) in the morning, (*b*) in the afternoon. (*a*) Bring $\frac{5}{10}$ to simplest form; $\frac{18}{20}$; $\frac{18}{20}$; $\frac{24}{96}$; $\frac{24}{84}$; $\frac{17}{153}$; $\frac{33}{77}$, etc. Is $\frac{5}{6}$ more or less than $\frac{1}{2}$? How much more? Find $\frac{1}{8}$ of a £; $\frac{1}{8}$ of a shilling; $\frac{1}{8}$ of a crown; $\frac{1}{8}$ of a guinea; $\frac{1}{8}$ of a cwt.; $\frac{1}{8}$ of a ton, etc. Is $\frac{15}{16}$ more or less than $\frac{3}{4}$? How much more? Find $\frac{3}{16}$ of a £; $\frac{3}{16}$ of a guinea; $\frac{7}{16}$ of a crown; $\frac{11}{16}$ of half a crown, = 1s. $8\frac{8}{8}$d.; $\frac{9}{16}$ of a ton, $= 11\frac{1}{4}$ cwt., etc. Add together $\frac{1}{2}$ and $\frac{1}{3}$; $\frac{5}{6}$ is how many 6oths? How many 30oths? $\frac{1}{4} + \frac{3}{10}$; $\frac{3}{8} + \frac{5}{8} + \frac{7}{14} = 1\frac{7}{12}$; $\frac{5}{6} + \frac{11}{16} = 1\frac{23}{48}$. How much is $\frac{21}{25}$? = 10s. 5d.; $\frac{3}{8} + \frac{11}{12} + \frac{7}{16} = 1\frac{35}{48}$. How much is $\frac{35}{36}$ of a guinea? = £1, 0s. 5d.; $\frac{3}{8} + \frac{7}{10} + \frac{17}{20}$, $= 1\frac{37}{40}$, $\frac{37}{40}$ of a £?

$\frac{3}{5} - \frac{1}{2}$; $\frac{4}{7} - \frac{2}{5}$; $\frac{7}{10} - \frac{5}{12}$; $\frac{14}{18} - \frac{7}{12}$, $= \frac{21}{60} = \frac{7}{20}$; $4\frac{5}{8} - 2\frac{2}{5}$, $= 2\frac{9}{40}$; $6\frac{3}{8} - 2\frac{3}{4} = 3\frac{5}{8}$; $7\frac{3}{10} - 3\frac{11}{18} = 3\frac{17}{90}$, etc.

Multiply $\frac{3}{8}$ by $\frac{5}{9}$, $\frac{1}{3}$ of £2, 10s., = 16s. 8d.; $\frac{7}{8} \times \frac{4}{15}$, $= \frac{7}{30}$,—how much less than $\frac{1}{4}$? $1\frac{1}{4} \times \frac{3}{8}$, $= 1\frac{5}{32}$,—

$\frac{1}{32}$ of a £ = 9s. 4½d. Here explain that $\frac{1}{32}$ is $\frac{1}{4}$ of $\frac{1}{8}$, and as $\frac{1}{8}$ = 2s. 6d., $\frac{1}{32}$ = $\frac{1}{4}$ of 2s. 6d. = 7½d.; $3\frac{7}{10} \times \frac{1}{2} = 2\frac{19}{20} = 2\frac{34}{20}$.

Divide $\frac{2}{4}$ by $\frac{5}{6}$, = $\frac{9}{10}$; $\frac{4}{5} \div \frac{3}{20}$, = $\frac{32}{15} = 2\frac{2}{15}$,—how much is $2\frac{3}{15}$ crowns; $1\frac{3}{4} \div \frac{5}{9}$, = $2\frac{11}{12}$,—how much is £$1\frac{11}{12}$? The lesson (*a*) which occupied about half an hour was closed with a more general question in mental arithmetic. What will 20 stone (each 14 lb.) of bacon cost at 9½d. a lb.?—9½d. × 14 = 10s. 9½d. a stone, then 20 stone at 11s. = £11, less 20 times 2½d. (4s. 2d.) = £10, 15s. 10d.

(*To be continued.*)

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Practical Lessons on Insect Life.

BY THEODORE WOOD,

Joint-Author of 'The Field Naturalist's Handbook.'

II.—THE METAMORPHOSES OF INSECTS.

As was mentioned in the preceding article, every insect passes through a series of changes, or more properly speaking, *metamorphoses*, before arriving at its perfect condition. These stages, three in number, are known as the egg; the larva, grub, or caterpillar; and the pupa, nymph, or chrysalis, the last of which terms, however, is only employed in the case of certain butterflies. We will now proceed to follow the insect through these developments.

In the first place, of course, we have to deal with the egg. In colour, size, and shape, the eggs of insects vary to a most wonderful degree, scarcely two forms being alike, and those of the most closely allied species often being totally different from each other. Some are plain, others chased and sculptured, covered perhaps with a raised network of wonderful intricacy, and enriched with all the colours of the rainbow. Some are round, others oval, square, oblong, or pear-shaped, while there is no limit to the patterns displayed upon them.

In point of numbers and situation, too, the eggs vary very greatly. A very curious arrangement is found in the common gnat.

The eggs of this insect greatly resemble a small skittle in shape, and are fastened together in considerable numbers, the whole batch forming a very perfect boat, which floats upon the surface of the water, and which cannot be upset or sunk by any accident. Even when forced beneath the water, it rises again to the surface as soon as it is released, and emptying out the water it has taken in, floats uninjured as before. In fact, the structure irresistibly reminds the observer of the most perfect life-boat which can possibly be imagined. These egg-boats, which are about the size and shape of a carraway seed, may be found in numbers in almost any rain-water tub throughout the summer.

Eggs of Gnat.

As a general rule, the eggs are laid by the parent insect either upon or near the food of the future larvæ, and after a lapse of time varying according to the insect, the enclosed grubs break through their cell and make their way into the outer world.

Almost as soon as they are hatched, the young larvæ begin the grand business of their lives, namely, eating, and in many cases make their first meal upon the empty egg-shell from which they have just emerged. From that time until their change into the pupal condition, they eat almost without cessation; and it has been computed that an insect, during this part of his existence, consumes more than one hundred thousand times his whole weight in food. And the reason is this, that the whole growth of the future insect takes place while it is in the larval state. It is an invariable rule that no insect ever grows when once it has attained its perfect condition, in spite of the popular notion to the contrary. The general idea is, that all small insects are necessarily young, and that as they grow older they will increase in size. So, a house-fly is considered to be merely a juvenile blue-bottle, and a gnat is expected to develop in due course of time into a daddy-long-legs, and so on, and it is often very difficult to persuade people to the contrary.

Another argument frequently brought forward in favour of the growth of insects is, that one often sees specimens of the same insect varying greatly in point of size. This is true enough; but both being perfect insects, will remain of the same size until they die; and it would be as reasonable to infer that the smaller might attain the dimensions of the larger, as it would be to state that a dwarf would grow into a giant. There are large insects and small insects, just as there are large and small men.

Now, taking into consideration the enormous quantities of food which a caterpillar requires, it necessarily follows that his increase in size must be proportionately rapid. And there is this drawback, that after a certain degree the skin will expand no further, and, although the creature is still obliged to continue eating, becomes most inconveniently tight. Now what is he to do? Eat he must, and his skin will stretch no further.

There is only one thing for him to do, namely, to burst, and this he accordingly does. The old skin splits down the back, and after a little trouble the caterpillar, clad in a bright new covering, crawls out from his old integument, which, as often as not, he immediately devours. No sooner has he recovered from his exertions than he again begins feeding, and continues to do so until his increase in size renders necessary another change of garments.

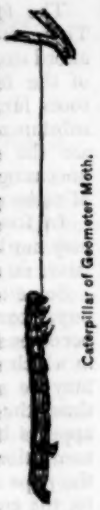
This operation takes place as a rule from four to six times during the life of the caterpillar, each operation consuming from twelve to twenty-four hours.

The forms of the larva are as various as those of

Larva of Tiger Moth.

the egg. We can hardly take a country walk in the early summer without noticing on the leaves of the nettle a number of brown hairy caterpillars, gener-

ally known as 'woolly bears.' These will in course of time develop into the well-known Tiger Moth. A little farther on, perhaps, we may find a group of black caterpillars thickly covered with stiff spines, which will later on become 'Peacock' Butterflies. Beneath the leaves, or hiding at the roots of the weeds, may be dug out a variety of perfectly smooth caterpillars, belonging to various moths. From almost any tree we may knock out a number of thin, stick-like objects, generally hanging at the ends of long silken threads, and which are also caterpillars.

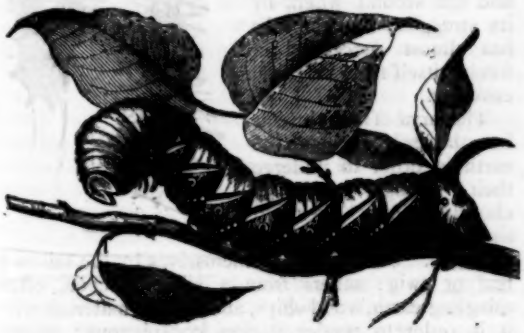


Caterpillar of Geometer Moth.

Then, a little later on in the year, will very likely be seen the larvæ of some of the Hawk Moths, such as the one represented in the accompanying illustration, and which are armed with a long curved horn at the end of the body, together with many more far too numerous to mention.

The larvæ of other orders of insects, too, present still other forms; but as merely to describe some of the more conspicuous would more than fill the entire space assigned to this article, I shall confine myself to those of the more generally known butterflies and moths.

Upon examining the structure of one of these caterpillars, it will be seen that it possesses all the chief characteristics of the insects. It is now, just as in the perfect state, composed of thirteen segments, and the legs correspond in number.



Larva of the Privet Hawk Moth.

The organs of the various senses are not developed to an equal degree with those of the perfect insect. Instead of the enormous compound eyes, with their thousands of lenses, a caterpillar is limited to a few simple ones, twelve in number, which are placed six upon each cheek close to the mouth, and are so highly convex that they can convey no impression to the optic nerves unless brought almost into contact with an object. The antennæ, too, are very small.

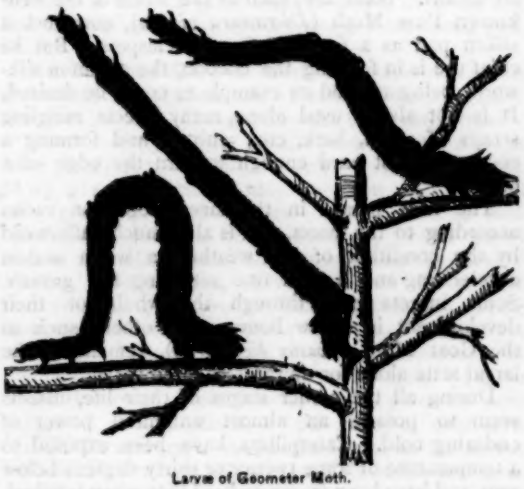
Besides the six true legs, which answer to those of the perfect insect, and are placed upon the same segments, a caterpillar is furnished with several false legs, or claspers, varying from four to ten in number. The difference between the two forms is very marked. The true legs are jointed, just as is the case in the perfect insect, and are provided with hooks or claws for the purpose of obtaining a firm foothold. The claspers, however, are nothing more than mere fleshy pads, surrounded by a circle of small but strong hooks, with the points directed inwards, and formed in such a manner that the air can be exhausted and a vacuum formed, just as is the case in the well-known 'sucker,' so common as a toy. The grasping power of these claspers is very great, and it is quite impossible to forcibly remove many larvæ from their footing without either severely damaging or killing them outright.

Legs of Caterpillar.

Clasper of Caterpillar.

In the larvæ of the *Geometræ*, or Looper Moths, the three first pairs of claspers are wanting, the remaining two pairs being situated at the very end of the body, and in consequence the caterpillars proceed in a very extraordinary manner. Grasping firmly the leaf or twig upon which it is resting with the true legs, the creature arches its body double, plants the four claspers immediately behind the feet, and taking a firm hold with them, extends the body to its utmost length in front. A second grasp is then taken with the legs, the body arched, and the claspers drawn up as before, and so on.

Geometer Larva. Mode of Walking.



Larvæ of Geometer Moth.

These larvæ have a curious habit when at rest of grasping a branch by the claspers alone, and stretching out the body at right angles to it, when from their colour and markings they bear so close a resemblance to a small twig that the most practised eye will often fail to discern them.

The interior anatomy, also, of a caterpillar is well worthy of examination. As a general rule, people do not seem to think that caterpillars have any internal organs, and this popular idea was well summed up by a gentleman who, on seeing one dissected for the first time, was astounded, and said that until then he had always thought that they were 'nothing but skin and squash'!

Living practically for no other purpose except eating, the interior is almost entirely occupied by the digestive organs, and upon opening a larva the first idea would probably be that it was all stomach,

with a coating of fat. And, in point of fact, the stomach occupies about nine-tenths of the available space, the rest of the digesting organs being very slight.

The circulatory nerves and respiratory systems are much the same as in the perfect insect, but are more easily examined.

A point of the structure of the larva not possessed by the perfect insect is found in the silk glands. These are two in number, one upon each side of the body, and are provided with ducts, which unite in the spinneret, an organ of the simplest description.

The silk, while still contained in the glands, is merely a rather thick, viscous fluid. When about to make use of it, the caterpillar places the spinneret in contact with some object, exuding at the same time a drop of the liquid, and sharply withdraws it. The silk immediately hardens upon exposure to the air, and is drawn out into an exceedingly fine but strong thread, which is able to sustain the whole weight of the caterpillar without giving way.

This silk is used for various purposes. At the approach of danger, many species of caterpillars allow themselves to fall from the branches and hang at the end of their threads until it is past, trusting to their resemblance to pieces of twig to deceive any hungry bird. Others, gregarious in their habits, spin huge webs in which to reside; others, again, bend the edges of leaves together and fasten them by its means. Some few, such as the larvæ of the well-known Puss Moth (*Dicranura vinula*), construct a silken pad as a foothold for the claspers. But its chief use is in forming the cocoon, the common silk-worm being as good an example as could be desired. It is not always used alone, many insects mingling scraps of wood, bark, etc., with it, and forming a cocoon almost hard enough to turn the edge of a knife.

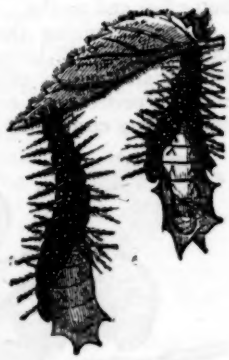
The time passed in the larval condition varies according to the insect, and is also much influenced by the condition of the weather, a warm season accelerating and a cold one retarding the growth. Some insects pass through the whole of their development in a few hours, while others, such as the Goat Moth (*Cossus ligniperda*), remain in the larval state alone for upwards of three years.

During all the earlier stages of their life, insects seem to possess an almost unlimited power of enduring cold. Caterpillars have been exposed to a temperature of some twenty or thirty degrees below zero, and have been frozen so hard that, when touched, they snapped asunder like glass; yet, upon the surrounding atmosphere being raised to the normal temperature, they revived, and seemed none the worse for their experience. Many pupæ, too, which lie fully exposed to the elements during the winter, will pass through the severest frosts without injury. It is often said that a cold winter will be good for the crops, as great numbers of the insects which devour them will be killed by the cold. In reality, however, it is rather the other way; for, while the insects are uninjured, the small birds which prey upon them perish in hundreds for want of food, so that, when the warmer weather arrives, the insect pests perform their ravages comparatively untroubled by their feathered enemies. Wet, however, insects cannot endure, and a very damp autumn always produces a most perceptible effect upon the abundance of insects during the ensuing summer.

The food of larvæ is as varied as their forms. There is scarcely a plant or tree which does not afford sustenance to many caterpillars, either by means of the foliage or the wood itself. Even the very roots furnish food to many species. Such repulsive substances as carrion, the droppings of animals, etc., are the resort of thousands of insects, to whose unceasing labours we are indebted for the prevention of many noxious diseases.

In fact, there is hardly any place in which insects may not be found, or any substance upon which their larvæ do not feed.

Some two or three days before its change into the pupal condition, the caterpillar ceases feeding, and becomes sluggish and irritable. It then seeks a place in which to undergo its transformation, and where it may be safe from the attacks of enemies. After a time, the skin splits down the back, and the pupa appears beneath. By means of sundry wriggles and contortions the larval skin is at last got rid of, and the pupa then lies quiescent until the time approaches for the enclosed imago to escape. During this time it is nourished by the stores of fat which it laid up while it was still a caterpillar, just as hibernating animals subsist upon their accumulated fat during their period of inactivity.



Chrysalides.

In the accompanying illustration will be seen two different stages of the transformation, the first being taken soon after the commencement of the operation, and the second when, by its struggles, the chrysalis has almost succeeded in freeing itself from its larval covering.

The larvæ of many insects bury themselves beneath the earth in order to undergo their change, generally choosing some sheltered situation, such as the roots of a tree. Some suspend themselves by the tail to a leaf or twig; others from a silken cocoon, often mingling earth, wood-chips, and similar materials with it in order to render it less conspicuous; others, again, fasten themselves to some object by means of a silken band round the body, and so on.

In the *Lepidoptera*, or butterflies and moths, and many other insects, the pupa is entirely without the means of locomotion, and remains in a state of perfect quiescence until the time arrives for the perfect insect to break forth. But in many insects, notably

Pupa of Pieris brassicæ.

the dragon-flies and others, whose earlier stages are passed beneath the water, the pupal form differs in but a slight degree from the larval, and still retains the power of locomotion, the whole habits of its life, indeed, being but little altered.

'How I teach Elementary Science.'

OBJECT LESSONS.

BY R. BALCHIN,

Head Master of the Gloucester Road Board School, London.

IN the ordinary course of school life, there are, as I stated in last month's paper, two opportunities for teaching Elementary Science, viz.:—'Object Lessons,' and the preparation of the subjects specified in the 'Fourth Schedule.' In the present condition of things, the former is a better opportunity than the latter. Hence I am devoting another article to the question of 'Object Teaching.' The reason for Elementary Science being taught better through the medium of these lessons than by taking up the 'Fourth Schedule' subjects is simply this: The latter is the subject of annual written individual examinations for grants, the former is not. Hence the superiority of the former. The School Board for London has, I believe, decided to give annual grants for success in object-lesson teaching. Good, as an encouragement. But if this grant is going to depend upon some annual written individual examination of the boys, with a view of discovering how many object-lesson facts they can put down on paper, then farewell to Science teaching altogether in most of our schools. Do Inspectors and others know what really happens to Science teaching, in expectation of their annual visits? It is this. For six or seven months in the year, some really good thoughtful lessons may be given: the boys are interested, and the subject is liked; but for four or five months before the Inspector's visit, teaching stops, and manœuvring begins: the interest of the boys flags, and the subject is disliked. Object lessons, on the other hand, not being at present degraded by any silly method of examination, the teacher need not in connection with them prostitute his powers to unworthy aims.

The scheme at present in working at Gloucester Road is somewhat as follows (we have, it should be remembered, a good museum, described in my last article, and a staff of able teachers):—

For Standard I.—The things most frequently before the eyes of the children should serve as the 'objects;' such as 'slate,' 'chalk,' the 'stone steps,' 'windows,' 'paper,' 'books,' 'ink,' 'rain,' 'dew,' 'snow,' 'wind,' and so on. A short course of lessons also on properties, illustrated by objects. It is a good plan to take for a single lesson some pair of opposite properties; such as 'hardness and softness,' 'roughness and smoothness,' 'light and heavy,' 'coarse and fine,' 'bright and dull,' and so on. Some conversational lessons on animals and plants should occasionally be given. I have found it a good plan at times to let the boys themselves suggest the subject.

As to the manner of giving these lessons, it must be borne in mind that the purposes to be served are—first, to lead the boys along lines of correct thought; second, to impart new ideas and fresh words to represent them, never forgetting that the possession of the idea should precede the definition of it.

For the First Standard, a half-hour is long enough for a lesson. What are called 'black-board notes' are an abomination. I only use the black-board for writing down the new words that are to form the addition to the boys' vocabulary, and to make rough scraps of drawings; both to be done as they occur in the lesson. Let the board be blank to begin with.

For Standard II.—Here, in addition to the subjects above mentioned, there may be given lessons leading up to the work of Standards IV. V. and VI. in the special subjects. At Gloucester Road we are taking Botany and Mechanics. Hence, simple lessons on the parts of a buttercup, a daisy, a primrose, a geranium; eatable plants, poisonous plants, etc. Never give a botany lesson unless a number of specimens can be obtained, either dried or fresh. The boys will bring them. In this Standard further properties of matter may be described, such as 'toughness and brittleness,' 'elasticity,' 'flexibility,' 'weight,' etc. Here also the three states of matter—solid, liquid, and gaseous—may be shown and explained, but avoid precise scientific definitions for the present. Be content with showing the objects that possess these properties, but never mind about scientifically defining the properties themselves. Don't, for instance, tell boys in the Second Standard, as I once heard an ambitious pupil teacher do, that 'wrought iron is tough or tenacious because the molecules of the substance are held together strongly by the attraction of cohesion.' Simply say, 'We call wrought iron—such as this piece of a poker—tough, because it takes a great force to pull it in two; not like this roll of putty, which you see I can easily pull apart.'

For Standard III.—At this stage lessons may be given on our manufactures. These will help to make the class subject—Geography—the more attractive.

'Iron,' 'cotton,' 'gas,' 'silk,' 'leather,' etc. Always have plenty of specimens. Don't forget the museum. More advanced lessons may be given on the parts of a plant, such as 'leaves,' 'roots,' 'stems,' and 'blossoms;' different kinds of woods, 'forest trees,' and so on. Elementary ideas respecting the 'lever,' 'pulley,' 'wedge,' etc. Try to procure the models that are said to be at the Board Offices, but which, however, I have written for several times and not yet obtained. Lessons also on simple machines, such as the 'pump,' 'a pair of bellows,' or a 'lock.' I have found that good object lessons may be given on such things as a 'lead pencil,' a 'pen-knife,' a 'candle,' a 'pen,' 'limestones,' 'sandstones,' and, as far as the collection will allow, on most of the metallic and non-metallic minerals. In these latter lessons simple experiments may be performed.

In Standards IV. V. and VI., I generally make the object lessons altogether supplementary to the teaching of the special subjects. As we take two 'specials,' necessitating the giving of four lessons per week, I cannot find time for two object lessons in addition. I therefore in these Standards take one object lesson per week in the time set apart for special subjects. The lessons in this part of the school are often on Chemistry. I have just finished a course of six lessons, with experiments, on 'a piece of chalk.' And my senior assistant, Mr. Allen, is about to begin a course on the gases. He has just completed a series of lessons on Electricity and Magnetism. It is quite amusing to see the apparatus which the boys in Standards V. and VI. have themselves constructed. One boy has made a capital electrical machine out of a large pickle jar, which gives a really large spark.

Another boy has converted a medicine bottle into a good electroscope. We have dozens of Leyden jars made out of jam bottles, as well as batteries which have previously done duty as gallipots.

This article completes what I have to say on the question of object teaching. Next month I will describe the methods carried out at Gloucester Road for teaching the Science subjects of the 'Fourth Schedule.'

'A Talk about Language and Grammar.'

(*Continued from page* 132.)

BY MARTIN F. TUPPER, D.C.L., F.R.S.,
Author of 'Proverbial Philosophy,' etc.

AND now at length, having preliminarily been thus discursive about language as the verbal exponent of thought, let us address ourselves to the ranks into which words are naturally divisible, and the rules which regulate their form and order; let us have a definite talk about Grammar. The Greek word *gramma*, a writing, is obviously the origin of the term; and its English synonym—or 'same name'—is the art of writing or speaking correctly in the expression of thought. The words of any sentence in every tongue must consist mainly of these: first, there are the names, or, as the grammarian writes it, the *nouns* (*nomina*) or qualities of things, as a tree, green, beauty, beautiful. These names or, in Anglified Latin, nouns are either expressive of a whole idea—as a tree, or beauty, and are therefore called substantives capable of standing alone—or of things which only help to make up an idea when added to such substantives, as green, beautiful, etc.; and so they are called noun-adjectives, as adjected or added to their principals.

Proper nouns are merely names peculiar to persons or places, as John, Cæsar, Hampstead, Rome. After the nouns, consider, secondly, the useful little words that are handles to them, and called Articles, so called from meaning 'a little joint,' or morsel of speech helping to hold a sentence together; 'a' being called indefinite, as *a* man, which might be any man; and 'the' definite, as by *the* man indicating some particular man. In English we have only these two articles unchangeable; but in most modern languages, our own excepted, they change to show the gender or so-called sex of the noun. Greeks and Latins had three genders—male, female, neuter; the French have but two, omitting the neuter, which, strangely enough, is practically the only gender with us for ordinary nouns, though we sometimes vary this fancifully by calling a ship she and her, as if the sailors' beloved; the sun 'he,' and the moon 'she,' which our German neighbours contradict, and make the sun feminine, and the moon masculine, for some reason of ancient mythology; but in fact, nearly every language but our own is grievously encumbered with needless difficulties relating to the gender—that is, 'genus,' or breed or generation—of nouns.

To the three regular genders, masculine as 'a bull,' feminine as 'a cow,' and neuter, or neither, as 'a chair,' may be added a fourth, as 'an eagle,' he or she; this fourth class is called epicene; which ill-looking Greek word simply means common. It is manifest that in every language a feminine noun substantive must, if it have any quality added to it (that is, if accompanied by any noun adjective), cause that addition to be feminine also; such agreement being styled a concord: and though in English (which seldom alters the terminations or ends of words) the word 'fair,' for example, looks the same in letters whether applied to a man or a woman, it is clear that it would be necessarily masculine in the first instance, and feminine in the second; in Latin, the one would be 'pulcher,' the other, 'pulchra;' in French, 'beau' or 'bel' would change to 'belle.'

But let us come, secondly, to the principal *word* in every sentence, without which it cannot cohere or express anything: this is called emphatically the *verb*, from the Latin 'verbum,' a word. In any sentence, when you have taken away the nouns substantial and additional, very little is left of consequence except the verbs. There will indeed remain, thirdly, the *adverbs*, or words added to the word, as 'away,' from he ran; 'truly,' 'foolishly,' 'quickly,' etc., such adverbs in English being chiefly an adjective with the termination 'ly;' a corrupted form of 'like.' Fourthly, the part of speech called a Pronoun is a word used instead of a noun,—'pro,' for, 'nomine,' a name; as he or him for George,—instead of constant nominal repetition. A relative pronoun is one of those little substitutes for nouns which refers or *relates to* something spoken of before; as every man *who* lives; all things *which* exist, etc. A certain class of pronouns are called possessive, and are in the nature of adjectives, as *my* horse, where my is evidently masculine as agreeing with horse; *your* cows, where your must be both feminine and plural, to agree or join harmoniously with the word cows. The word plural will catch your eye or ear as requiring explanation. In English (and indeed in all languages but the learned ones, which make a special distinction in favour of two only, or the *dual*) there are only two numbers; namely one, and more than one, or many. The first is called singular, from the Latin 'singulus,' meaning one or separate; or plural, from the Latin 'plus,' meaning more than one. There are, fifthly, some few other sorts of words—or parts of speech—such as these: interjections, or little words or phrases (Greek for sentences) thrown in between; 'inter,' between, 'jacta,' thrown. Also, copulatives, joining sentences together, as and, also, beside, etc.; with which may be classed such disjunctives as or, but, etc. Then there are the prepositions, or little words placed before ('præ, posita') the nouns; and these are of special use in English as the only means of showing the *cases* or accidents to which the noun is exposed: as, The hare was shot *by* Peter *with* a gun: I am going *to* London *for* some books. The word 'parsing' a sentence, as used by grammarians, would seem to be derived from taking each individual word *per se*, by itself, and showing its nature and use in the formation of the sentence in which it may be standing; another derivation may be 'pars,' a part, or 'partim,' in parts.

As to the classes of nouns; in English and most modern languages, the names of things, or nouns substantive, are comprised in one class, and not divided into what classical grammarians call declensions or steps. But in Latin and Greek, which are tongues of a more regular construction than ours, the case is different. Let us take Latin nouns as a subject for this talk. Most people are probably ignorant of the reason why the Latins made five

classes, or declensions, of their nouns substantive—neither more nor fewer: and no book known to the writer states it; but it is always pleasant and satisfactory to discern the root, or reason, for a fact. Take, then, this idea: there are five vowels, or open vocal sounds, a, e, i, o, u. The Latins would seem to have arranged their nouns under the key-notes of these vowels, changing their order for reasons best known to themselves. As thus: A is the genius or presiding sound of the first shelf or declension, whereon the nouns are flung in bundles, every noun in it and every case or change of the noun being full of the letter a. We all recollect 'musa,' 'fama,' etc. E is the guiding letter of the fifth declension, occurring similarly in every case of those nouns. Look at 'facies,' 'spes,' etc. I governs the third class of Latin nouns, occurring in three at least of the cases both singularly and plurally; and here let us remember, that in the oldest Latin poets, as Ennius, and in the Greek nouns of this class, such terminations as 'es' were anciently written 'eis.'

(To be continued.)

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Recent Inspection Questions.

[*The Editor respectfully solicits contributions to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

(1) Add together eight hundred and six, seven hundred and twenty, fifty-four, three hundred and seventy-one, and nine. Ans. 1960.

(2) From eight hundred and ten, take ninety-three. Ans. 717.

(3) Write out the six times table.

Note.—The following words were given as an exercise in Dictation:—

sugar	**hammer**	**field**
milk	**worm**	**useful**

STANDARD II.

(1) Multiply fifty thousand eight hundred and twenty-one, by two hundred and forty-six. Ans. 12,501,966.

(2) Divide seven hundred and nine thousand five hundred and sixty-one, by six. Ans. 118,260 + 1.

(3) Divide ninety-one thousand four hundred and eight, by eight. Ans. 11,426.

STANDARD III.

(1) Divide four hundred and two thousand three hundred, by one hundred and thirty-five. Ans. 2980.

(2) Find the sum of four thousand and ninety-two pounds eighteen shillings and fivepence, and four hundred and twenty-nine pounds seventeen shillings and eightpence. Ans. £4522, 16s. 1d.

(3) Subtract forty-nine pounds sixteen shillings and twopence halfpenny, from nine thousand four hundred and two pounds eleven shillings and eightpence farthing. Ans. £9352, 15s. $5\frac{3}{4}$d.

(4) Write in figures ninety millions and eighty-one. Ans. 90,000,081.

STANDARD IV.

(1) Multiply seven hundred and sixty pounds fourteen shillings and tenpence farthing, by one hundred and sixty-eight. Ans. £127,804, 15s. 6d.

(2) Divide ninety-seven thousand four hundred and fifty-eight pounds five shillings, by one hundred and fifty-two. Ans. £641, 3s. $5\frac{1}{4}$d. + 120.

(3) Reduce one hundred and forty thousand five hundred and sixty grains to pounds (Troy). Ans. 24 lbs. 4 oz. 16 dwt. 16 grs.

(4) If the circumference of a wheel is twelve feet, how many times will it turn round in going three miles and a half? Ans. 1540.

STANDARD V.

(1) Make out in proper form and settle the following provision merchant's account:—$17\frac{1}{2}$ lbs. of cheese at 8d. per lb.; 14 lbs. of bacon at $6\frac{1}{2}$d. per lb.; 40 lbs. of butter at 1s. per lb.; 20 lbs. of butter at 8d. per lb.; and $12\frac{1}{2}$ lbs. of lard at 6d. per lb.

	£	s.	d.
Ans.	0	11	8
	0	7	7
	2	0	0
	0	13	4
	0	6	3
	£3	18	10

(2) If 15 lbs. cost £20, what will one ton cost? Ans. £2986, 13s. 4d.

(3) Find the value of 14 yds. 3 qrs. 3 nls. at 15s. 6d. per yard. Ans. £11, 11s. $6\frac{1}{4}$d.$\frac{1}{2}$.

(4) How many yards of cloth at seven shillings and sixpence a yard can be bought for a hundred pounds? Ans. $266\frac{2}{3}$ yards.

STANDARD VI.

(1) Reduce four shillings and eightpence halfpenny to the decimal of a sovereign. Ans. ·235416.

(2) Simplify $(11\frac{1}{2} - 8\frac{1}{4}) \div (3\frac{1}{2} + 2\frac{1}{4})$. Ans. $\frac{13}{23}$.

(3) How many days would 120 bushels of corn last 18 horses, if 20 bushels last 12 horses 10 days? Ans. 40 days.

(4) Divide the product of 16·004 and ·004 by 2·08. Ans. ·030776 +.

Domestic Economy.

(1) How would you clean a floor?

(2) How would you clean furniture and fire-irons?

(3) State the best mode of warming and ventilating a house.

(4) Which is the best washing day? What preparations would you make for it?

(5) How should flannel be washed?

Grammar.

STANDARDS IV. AND V.

Parse and analyse, 'The birds flew away to warmer lands in winter.'

STANDARD VI.

(1) Parse and analyse, 'When their supply of food fails them, they seek warmer climates.'

(2) Write a letter to a friend telling him how you spent last Saturday.

RADISHES AND ONIONS.

Words by GEORGE BENNETT.
Music by T. CRAMPTON.

Cheerfully.
mf
1ST TREBLE.
2D TREBLE.
BASS.
1 We are off to Cov - ent Gar den, Tom and Kate and I. We have
2. 'Tis not much we have to lay out On the gar - den store. It won't
3. Here's a lot to us they prof - fer, Good and cheap, you see. Let us
KEY F. Cheerfully. mf
C. t.
1ST TREBLE. : s . , s | s . m : s . l | s . m : | s . r : m . f | m . : m l . l
2D TREBLE. : m . , m | m . d : m . f | m . d : | t1 . t1 : d . r | d . : s1 d . d
BASS. : d . , d | d . d : d . d | d . d : | s1 . s1 : s1 . s1 | d . : d f . f
just saved ten - pence far - den, So our luck we'll try; Rad - ish - es are just in
last us half the day out, But we'll soon get more; For we know the pro - fit's
close now with the of - fer, Then to sell we're free, We shall soon save up to-
f. F.
l . s : s . f | m . s : | t . d' : r' . t | d' . : s r . m | r . r : s . f
t1 . t1 : r . r | d . m : | r . m : f . r | m . : m t1 . d | t1 . t1 : t1 . s1
r . r : t1 . t1 | d . d : | s . s : s . s | d . : d s1 . s1 | s1 . s1 : s1 . t1
sea - son, On - ions too are fine, And we know there is no rea - son
dou - ble What we have to pay; And we'll ne - ver mind the trou - ble,
ge - ther, And a don - key buy; Then we'll heed not wind nor wea - ther,
C. t.
m . d : | m . l : se . t | l : l r' . r' | r' . s : s . s | s . d' :
s1 . s1 : | d . d : t1 . r | d : d f . f | f . f : f . f | m . m :
d . m : | d . l1 : m . m1 | l1 : l1 r . d | t1 . t1 : t1 . t1 | d . d :
CHORUS.
mf
We should pinch and pine. Bet - ter work than play. If we on - ly try.
So we'll shout the streets a - long—
f
'Rad-ish-es and on-ions!'
f. F. CHORUS. mf
f
r' . f' : t . r' | d' | : d' s . , f | m . m : m . m | s : - . | l , s . f , l : s . m
l . l : f . f | m | : m t1 . , t1 | d . d : d . d | m : - . | f , m . r , f : m . d
f . r : s . s1 | d | : d s1 . , s1 | d . d : d . d | d : - . | :
'Rad-ish-es and on - ions!' Lis - ten to our mer - ry song— 'Fine young rad-ish-es and on - ions!'
f
: | s . d' : s . f | m . r : d | l . s : r , m . f , s | m . d
: | m . m : r . s1 | s1 f1 : m1 | d . d : t1 , d . r , t1 | d . m1
f s1 , s1 . s1 , s1 : s1 . d | d . d : t1 . t1 | d . s1 : l1 | f1 . m1 : s1 , s1 . s1 , s1 | d . d

The Practical Teacher.

A MONTHLY EDUCATION JOURNAL.

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John Richard Langler, B.A., F.R.G.S.,

THE PRESIDENT OF THE NATIONAL UNION OF ELEMENTARY TEACHERS FOR 1881.

A NECESSARY effect of the arrangements and organization of the N.U.E.T. has been to bring into prominence, year by year, teachers distinguished among their fellows for their personal worth and general ability. These qualities, when combined with energetic action, give influence in any sphere which affords opportunity for their exercise. Illustrations of this general principle are especially noticeable in the inception and working out of new schemes involving widespread interests, affecting, variously, different and diverse classes and conditions of society, and necessitating complicated details of organization and effort. *Many*, as was meet, contributed, each one according to his several ability, much or little, to the common store of fact, and thought, and opinion which set forth the necessity, and gradually showed the practicability, of this great association of teachers. A *few* only, as was inevitable, brought the comprehensiveness of view, the practical sagacity, the prudence, the tact, and the patient vigorous labour, so to bear upon the gathered materials as out of them to construct the Union and to carry it on to its present development.

No wise man would expect any human scheme to reach the twelfth year of its existence absolutely free from fault, or from error in its progress; but the Elementary Day-school Teachers of England may be congratulated on the position and status occupied by their National Union to-day, and may well be thankful if twelve years hence it shall have made a corresponding advance in number and in influence, and be found equally well adapted to the altered conditions which National Education will then have assumed. For the result thus far achieved, the Union is largely indebted to the skilful and self-denying efforts of the small company of teachers who, in 1870, first established the Union, and to their co-workers and successors who have secured its present issue. They were fortunate in the admirable selection, made by the Union, of their first paid secretary, whose singleness of purpose, sagacity, and ability are so universally and deservedly recognised. And the successive Presidents have, on the whole, done honour to their choice. The responsibility attaching to this office is not inconsiderable. During the sitting of Conference, public attention is, year by year, increasingly directed to the words and acts of its chief officer; during the year of his presidency, his influence largely sways the decisions and deeds of the executive; in interviews with officers of the Education Department, or Members of Parliament; as representative of the Union at meetings of other educational bodies; and in various other ways, much depends for good or harm, to the interests of teachers, and the higher and more important interests of National Education, on the wisdom and the personal character of the President.

For these reasons the President should ever be, not only one whom his fellows delight to honour by the office, but whose qualifications shall enable him to bring honour to the office. In the President for 1881, these requirements seem to be combined in a pre-eminent degree. Mr. John R. Langler, B.A., F.R.G.S., is a practical teacher of proved ability and of very varied acquirements. His teaching experience, in what is sometimes denominated the Primary Education of the country, touches the two extremes of the management and instruction of infant schools on the one hand, and the work of tutor in the advanced classes of a Training College on the other, ranging also through various grades and degrees of classes between these extremes. He is also practically acquainted with the methods and requirements of Secondary Education, having been for some time junior assistant in Sion House Academy, Jersey, in which admirably-conducted and well-known school he had been previously a pupil.

Mr. Langler thus possesses that essential qualification to a just and comprehensive view of the work of teaching, and the life of a teacher, which can be acquired in no other way than by actual participation in several departments and conditions of both. His preparation for the work, which has occupied the greater part of his life, was varied and ample. Born in Devonshire at Brixham-on-Torbay, in 1826, he was very early sent to school at Dartmouth, under the care of the Rev. J. Greaves, M.A. At eleven years of age he was entered as pupil at Sion House Academy, Jersey, as already mentioned. The Principal was Mr. E. Neel, and the late Dr. Kessen was senior tutor. An incidental advantage of his residence here was the acquirement of an accurate knowledge of the French language, which he learned to speak with great facility. While assistant-master in this institution, Mr. Langler was offered the charge of a school at Gaspé in North America, where French was generally spoken; but having then a desire to enter on missionary work, he declined the invitation.

At this time the Wesleyan Education Committee had entered upon the work of establishing day schools in connection with their community in various parts of England. An essential part of the system was the preparation and training of teachers. As, after due inquiry and consideration, they had decided upon the adoption of the 'Training System' of education as developed by Mr. David Stow of Glasgow, the young persons selected as teachers were sent for training to

the Normal College established in that city by Mr. Stow. In 1844 Mr. Langler offered himself for this work, was accepted, and duly entered the institution.

At that time the Glasgow Training College was in the zenith of its fame. Mr. Stow, in the prime of his energy, diffusing among the students his own enthusiastic love of teaching; Mr. Hislop, the rector, vigorous, accomplished, of rare personal influence; Mr. Fraser (afterwards LL.D.), an able, earnest, and graceful teacher; Mr. David Caughie, *facile princeps* of infant teachers; and Mr. W. Sugden, B.A., for more than thirty years the highly-esteemed head master of the Westminster Training College—all of whom have now passed from amongst us—were then earnestly and happily engaged in the training of the students. The formative influences of such a place and time were great, and Mr. Langler yielded himself up to them with sympathetic ardour. He became thoroughly versed in the principles and methods characteristic of the Glasgow Training System, and developed especial skill in their application. This led to his appointment as master of the infants' department of the Rusholme Road School, Manchester, in 1845; and in 1850, to the charge of the same department of the practising schools of the Westminster Training College. These schools were designed on the model of those at the Glasgow Normal Seminary.

From a Photograph by the London Stereoscopic Company.

Here his work was most congenial. His ardent desire was to have the best infants' school in the country; and his loving sympathy for the little ones, the respect he won from their parents, his unflagging zeal, and daily conscientious preparation, coupled with the lofty conception he had formed of the true nobility of the teacher's work, certainly contributed in no small degree to the attainment of that end.

For a short time he was the master of the Model School. Much of his time was devoted to the instruction of the students, male and female, who first became resident at Westminster, in 1851. He took special charge of the classes in School Management for the infants' and girls' schools, and gave instruction in Arithmetic, Geography, and French. In 1856 he obtained, on his first examination, a Lectureship in Geography, of the value of £100 per annum (as proposed by the Rev. Canon Moseley), and held it until the advent of Mr. Lowe's famous Code of 1861, which took away all personal payments. On obtaining the Lectureship he became a Fellow of the Royal Geographical Society, and shortly after, he graduated B.A. at the London University.

At a date long prior to this, however, viz. in 1848, Mr. Langler had obtained a Government Certificate, having sat for this purpose at the first examination accessible to Nonconformists, under the Minutes of Committee of the Privy Council for Education, issued in 1846. His name appeared second on the list of successful candidates, Mr. Crampton, of musical fame, being the first.

As the work of the College became fully developed, Mr. Langler was relieved from service in the schools, and his time was devoted entirely to the work of tutor to the students. His varied acquirements, genial disposition, and enthusiasm in teaching, made him a great and general favourite with his pupils.

For a quarter of a century he proved himself a 'faithful servant.' Of the spirit in which that work was done, and of the value set upon it by those whose high privilege it was to be influenced by it, we can, perhaps, give no better idea than by culling the following extract from the address which, with several valuable presents, was given to Mr. Langler in 1875 by the students then in residence, upon his accepting the office of lay secretary to the Wesleyan Education Committee: 'We desire to express the esteem and affection which we have for you, and the high regard which we have ever entertained for your character and work. We are deeply sensible of the great kindness and affability which always characterized your dealings with us, and grateful for the lively interest which you ever took in our welfare. We shall always cherish the memory of our connection with you as one of the brightest recollections of our college life.'

Mr. Langler is the author of the following excellent and widely-circulated school publications: *The Pictorial Geography for Young Beginners*, *The Popular Astronomy*, and *Mathematical Geography*, a series of *Reading Sheets*, *Primer and First Reading Book*, *Spelling Books*, and *Table Cards*. He has also issued, in conjunction with Mr. Joseph Hughes, a series of *Standard Geographies*, though the greater part of this work, we understand, fell upon Mr. Langler's shoulders. For the compilation of all these, his exact know-

ledge and long experience have especially qualified him.

On the decease of the late William Hughes, Esq., the well-known geographer, Mr. Langler was appointed in his place as Examiner in Geography to the College of Preceptors. He is the departmental secretary for Training Colleges, and thus *ex officio* a member of the Council of the Education Society. He succeeded Mr. Thomas Smith as chairman of the Board of Directors of the Educational Newspaper Company.

Mr. Langler has been a member of the Executive of the National Union of Elementary Teachers since its formation in 1870. In this capacity he has rendered invaluable service to the profession. His work has been done quietly and effectively. He has been vice-chairman of the Benevolent Fund since its origin, and vice-chairman of the National Provident Society, and is one of the trustees of each of these funds. He is also a member of the Council of the Orphanage and Orphan Fund.

The honour conferred upon Mr. Langler by his appointment as President of the Union is well deserved. While resident in Manchester more than thirty years ago, he was a valued member of the Manchester and Salford Teachers' Association. He has ever shown himself anxious to advance the best interests of teachers, devoting time and energy unsparingly to promote this object. We believe the welfare of the Union is safe in his hands, if professional ability, knowledge of educational processes and needs, high moral worth, and prudent zeal in its service, can make it so. And we heartily wish for the National Union of Elementary Teachers, and its President, a year of peace and prosperity.

The Late William Sugden, B.A.,

Head Master of the Wesleyan Training College, Westminster.

MANY thousands of our readers in this and other lands will regret to hear of the death of Mr. Sugden, who for above thirty years was the head master of the Training College at Westminster. We have a mournful pleasure in reproducing Dr. Rigg's address, delivered at Battersea on the 10th May, the day of the funeral. He said :—

My dear Friends,—We sorrow not as those who have no hope. This is a mournful, yet it is a triumphant occasion; there is a mist of sorrow that dims the scene and the prospect, but there is much more than a glimmer of glory that comes through; there is a celestial morning that is breaking through the mist, there is the hope and the assurance of a blest eternity. It is not my duty this morning to deliver a memorial eulogy, or to make any attempt at funeral eloquence. There is no eloquence which can compare with that of this scene as I look around me, nothing which could so touch, nothing which could so deeply move, nothing that could so blessedly inspire as these relics before us, that tell of a noble history, that prophesy a blissful eternity—a completed felicity for the body, soul, and spirit of our friend departed. But it is my duty to say that we are gathered here this morning to mourn with a Christian mourning, and to rejoice with a Christian hope over the history of one who was no common man. Mr. Sugden was no common man; he held, in relation to the great work of Christian education in connection with our Church, a unique position. His memory is enshrined in very many hearts and souls—not only here, where he lived; not only at Westminster, where he laboured so long and faithfully; not only in England and in Scotland, where he was never forgotten, having once had there his place of abode and his sphere of influence, but throughout the whole world Mr. Sugden's memory lives—nay, it may not be known there yet that he has gone—but his memory, as that of Mr. Sugden who was known at Westminster, lives and is fragrant in every continent. I have met with those in America who have spoken to me of him; in South Africa there are distinguished teachers, Christian instructors, who were trained under him; in Australia there are several of that class, and there is one there especially—the head of the Prince Alfred College, Adelaide, who takes scarcely less than the foremost place amongst the teachers of that hemisphere—who was one of the favourite students under the care of Mr. Sugden; and in the isles of the sea and those wonderful mission regions there are teachers who have gone out to work amongst the natives after they had been trained under William Sugden's influence. I say, then, it is no common man whose decease has brought us together to-day. For wideness of influence, for pure unmingled beneficence of influence, there are few in our denomination who can compare with him. He was the son of a faithful, hard-working Methodist minister, a native of the mountainous region of the West Riding, and he was the brother of another Methodist preacher who is greatly beloved and esteemed. He was born in the year 1819, and went, I think in 1828, to the Woodhouse Grove School, where he was the friend of Mr. Frankland and Mr. Gregory and others I might name, and where he was well grounded by that famous master, Mr. Parker, especially in Latin and the science of numbers. When he was fourteen years of age he went to Leeds to learn the business of a civil engineer, and there, in the practical workshops belonging to the great engineering works of the Fairbairns, he obtained a mastery of mechanical knowledge; and there, also, he became grounded in the Christian faith. Many of his companions in these workshops were unbelievers, not a few of them disbelievers in anything like faith, either Christian or other; and amongst them, day by day, and year after year, he maintained his integrity as a believer in Christ Jesus and as a Methodist. Doubtless that intercourse somewhat tried the temper and quality of his spiritual understanding at times, and he found it difficult to hold his own; but the result was a breadth and strength and depth of religious faith and conviction such as comparatively few men have possessed. I believe it was the late George Browne Macdonald, one of our eminent ministers stationed at Leeds in 1842, who found William Sugden there, a young engineer, a member of society, and a local preacher, and he thought he would find a fitter field if he were transferred to the Education Department. The consequence was, that in 1842 or 1843 Mr. Sugden went to Glasgow, under the direction of the Methodist Education Committee, that he might there be trained for educational work. He was afterwards appointed to a school at Holmfirth, in Yorkshire. About the year 1843 the education movement in the Wesleyan denomination—under the chief direction of the Rev. John Scott—commenced; and in consequence of that, Mr. Sugden was sent from Holmfirth to Glasgow as the agent of the Committee, in order to take a kind of charge and guardianship of the students sent there. Mr. David Stowe, the great educationist, found in Mr. Sugden a congenial spirit, and made a place for him in his own practising schools attached to the Free Church Normal Seminary at Glasgow. In 1850 Mr. Sugden left Glasgow for Westminster, where he entered upon the task of organizing the practising schools. He returned to Glasgow for a few months to complete his studies for the University and take his degree; he returned to Westminster at Midsummer 1851, and remained there to the end, a period of nearly thirty years. For many years John Scott, as principal, and William Sugden, as head master, worked together—two nobly-mated men; and it is not too much to say that a great deal of the high character and bearing of the College and those who have been trained in it has been due to the character and influence of Mr. Sugden. He was a man of a very well furnished mind: there were very few departments of study that he had not made his own; he was a sound, sober, accurate thinker—a stedfast, hard student all his days; and doubtless that stedfastness of hard study till late at night, continued to the very end, shortened his days. But what an amount of work has been put into that life of sixty-one years! Mr. Sugden's influence always struck me as being something remarkable: he reminded me of a giant, almost in his bodily appearance; and his strength seemed to be much above the ordinary standard, but his gentleness was that of a woman, and his simplicity that of a child. One striking feature of his character was the quiet supremacy with him of duty. Of ambition he seemed to have none, unless that can be called ambition, to do all that belongs to a

man's duty in life as well as it is possible to do it, and equally whether in sight of others or not—in that respect he was like the great commander Wellington: duty was the one law that seemed continually to regulate and animate his life. He was not in any respect a demonstrative man, or one to talk much about religion, except sometimes in perfect privacy; but he was a man whose whole life had the light of religion always on its fringes, so that people saw and felt that the life of religion was throughout a part of its very web, of its very texture. In teaching at the College, his accuracy, his fulness of knowledge, and his keen and living interest with regard to Scripture, struck the students with whom he had to do. I have said that he was an assiduous worker in the pathway of duty. He was a devoted toiler for our College. He left College and came home, not to recreate, but to go into his room with his papers, and to inform himself on every subject which in his position he might be called upon to understand. There were very few works on physical science with which he was not well acquainted. There were few master works, indeed, in any great department of information which he had not carefully read. Such work, however, so long continued, could not but tell on his constitutional strength. For some time, those who were associated with him had noticed that he was gradually failing in strength: his eyes had become peculiarly affected, and his speaking was not as clear as it had been; in fact, there were infirmities coming upon him others could not but see it, and he himself knew it quite well. It could not be said that death at an early age surprised him: he never expected long life; his father died at the age of sixty-one, as the result of a sudden stroke, others of the family had died about the same age, and he has said to me many times that he could not expect to live to be much more than sixty years of age. Therefore, when there came that touch which disabled him last Christmas, he took it as a token that his years were coming to a close. Those who were present on the Friday before the Valedictory Address was delivered would never forget the spirit and love of Mr. Sugden's words on that occasion, nor his wan and pale look as he uttered them. He spoke with a little more effusion than was usual with him, almost as though he felt that he might not have another such opportunity of addressing an assembly of students about to leave the College. On the following Monday night he became unconscious in his room at home, and that was the beginning of the end. Some weeks afterwards he went to the Isle of Wight, and returned somewhat better not yet a fortnight ago. Last Tuesday he came to the College, having set his mind on doing a little work again. I took upon myself to say he should not take the reading; but I consented that he might try the Latin. He went into the College, said a few words to some of the students, and then went home, as he said, to prepare for the morrow. On the following day he went out into the park with Mrs. Sugden, was seized with palpitation, and walked slowly home. The heart had done its work; no artificial means could give back the vital warmth or force; he moved between the bed and the easy-chair, and as he reached the easy-chair for the last time, he threw back his head, and died between eight and nine the next morning (last Thursday). William Sugden was one of those characters with the remembrance of whom there is associated no single thought of darkness; his was a godly, consecrated life of unostentatious service as always in the sight of the Great Taskmaster. I have never heard of anybody who complained of any word of his that has rankled or left any bitterness or sting behind. Those who belonged to him may thank God in this hour of his removal and be filled with consolation. I may be permitted here to mention what was said to me by her who was—and is—nearest and dearest to him, that in the thirty years of their married life she had not only never known him say a harsh or a sharp word, but not even an inconsiderate word. Let us glorify God in him, and thank God we have had the services of such a man. At Westminster, in particular, he has been like a sheet-anchor all these years, and the traditions of his character and influence will live there from generation to generation. We have here the family that mourns, but I doubt not before long the God of consolation will have turned this sharp deep wound into a well-spring of purest comfort, holiest memories—a blessing to them, and all belonging to them, from generation to generation. My dear friends, death's shafts fly thick; how many of our friends, of my best and dearest friends, have gone, those about my own age, during the past eight or ten years! What is the lesson to us? That we must learn to look upon death without too much of sadness. We must learn to regard it as a transition, a translation; we must believe in the communion of saints, not only as respects this life, but as respects the life to come. Eternity must be a more real world to us than it has ever been. If that be the result of these frequent bereavements, these heartrendings, they will be blessed indeed, and we shall not only be able to look forward to our own change with perfect tranquillity, but be able to understand better the blessed meaning of the grand Christian glow of hope and joy and triumph which breathes in the inimitable hymns which it is our privilege to sing on these occasions; we shall learn to

'Rejoice, for a brother deceased.'

May we all learn this lesson! May God comfort the widow, guide and bless the fatherless; and may every one of us do our duty simply and humbly, as William Sugden did; and may we be, like him, ready for God's will at any moment through Jesus Christ our Lord!

Publications Received.

Arithmetic—

(1) Marshall's Arithmetic. Parts I., II., III. Marcus Ward & Co.

Athletics—

(1) Spencer's Bicycle Road Book. Griffith & Farran.

English History—

(1) Powell's Historical Reader. Longmans & Co.
(2) Gardiner's Outlines of History. Longmans & Co.

English Literature—

(1) Byron's Siege of Corinth. Chambers.
(2) Wordsworth's Ode to Duty. Chambers.
(3) Shakespere's Midsummer Night's Dream. London: Rivingtons.

Ethics and Morals—

(1) Hime's Morality. Guest.

Euclid—

(1) Cassey's Sequel to Euclid. Longmans & Co.

Fiction—

(1) Modern Wonders of the World. Strahan & Co.

Geography—

(1) Lupton's Geography. Longmans & Co.
(2) Ward's Child's Geography. Marcus Ward & Co.
(3) Universal Atlas. Marcus Ward & Co.
(4) Geographical Reader. Book III. E. Stanford.

Grammar—

(1) Daniel's English Grammar. Part I., price 3s. Part II., price 2s. 6d. Complete price, 5s.

Mechanics—

(1) Hewitt's Class-Book of Elementary Mechanics. Philip & Son.
(2) Browne's Mechanics for Junior Students. J. Heywood.

Music—

(1) Pearson's Notation of Vocal Music. Reeves.

Mythology—

(1) Bianchi's Mythology of Greece and Rome. Marcus Ward & Co.

Periodical Literature—

(1) Ward & Lock's Universal Instructor. Ward & Lock.

Science—

(1) Dunman's Starlit Sky. Griffith & Farran.
(2) Dunman's Pre-Historic Man. Griffith & Farran.

The Scriptures—

(1) New Testament, Revised Version London: Oxford and Cambridge Warehouses.

Writing—

(1) Marcus Ward's Improved Writing Copy-Book. Marcus Ward & Co.

Pupil Teacher's Examination Questions.

APRIL 1881.

CANDIDATES.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Find the cost of 199 yds. 2 ft. 4 in. at £1, 3s. 5½d. a yard.
2. How much will be left of £400, after an account for 303,296 ozs. at £43, 11s. 8d. a ton has been paid out of it?
3. The expense of keeping 6 horses for 7 months amounted to £118, 4s. 3d. Two of the horses were then sold; how long were the remaining horses kept for £123, 16s. 10d.?
4. If 6 men or 15 boys can do a piece of work in 18 days, in how many days will 4 men and 10 boys together do it?

FEMALES.

1. Make out the following bill:—

		s.	d.	
49½	stones of flour at	2	8	per stone.
76½	lbs. ,, cheese ,,	0	8	per lb.
101¼	,, ,, butter ,,	1	7	,,
20½	,, ,, tea ,,	3	4	,,
38½	,, ,, coffee ,,	1	5	,,
177¾	,, ,, pork ,,	0	9	,,

2. Find the cost of 48 cwt. 3 qrs. 3 lbs. at £1, 17s. 6d. per cwt.
3. 265408 at £10, 14s. 7½d. each.
4. Find, by Practice, the worth of 24510 rupees at 1s. 11¾d. each.

Grammar.

1. Point out and parse all the adverbs and adjectives in the following:—

'There is no breeze upon the fern,
No ripple on the lake,
The small birds will not sing aloud,
The springing trout lies still,
So darkly glooms yon hidden cloud,
That swathes, as with a purple shroud,
Benledi's distant hill.'

2. Show how verbs may be classified according to inflexion, that is, according to their mode of forming their past tense, and give one or two examples in each class.
3. Give the possessive case of the following nouns:—Child, children, prince, princess, John, James.

Geography.

1. What is the nearest seaport to your home? Trace, in words, a coasting voyage from it, either to London, Liverpool, *or* Bristol, choosing whichever is the most distant.
2. Describe minutely the basin of the Yorkshire Ouse.
If you can, draw a map in illustration.
3. Say what you know about the Scotch and Irish lakes.

Composition.

Write from dictation the passage given out by the Inspector.

Penmanship.

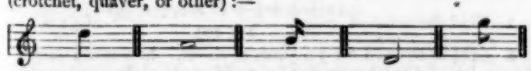
Write, in large hand, as a specimen of copy-setting, the word *Burglary*.

Write, in small hand, as a specimen of copy-setting, '*Now, Warwick, tell me, is Edward your true king?*'

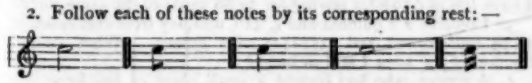
Music.

A quarter of an hour allowed for this paper.

1. Write over each of the following notes its pitch name (C, D, *Do*, *Re*, or other), and under each its duration name (crotchet, quaver, or other):—



2. Follow each of these notes by its corresponding rest:—



3. How many tones and semitones are found in a major scale, and what are the places of the latter?

ANSWERS—CANDIDATES.

Arithmetic.

MALES.

1.

£	s.	d.	
1	3	5½	×9
		10	
11	14	4½	×9
		10	
117	3	9	
105	9	4½	
10	10	11¼	

1 ft. 6 in. = ½ yd.	233	4	0¾	= value of 199 yds.	
9 ,, = ½ of 18 in.		11	8¾	= ,,	1 ft. 6 in.
1 ,, = ⅙ of 9 in.		5	10 1/12	= ,,	9 in.
			7 1/8	= ,,	1 in.
£	234	2	3½	= value of 199 yds. 2 ft. 4 in.	

2.

16 { 4)303296 oz.
4)75824

28 { 7)18956 lbs.
4)2708

4)677 qrs.

20)169 cwt. 1 qr.

8 tons 9 cwt. 1 qr. at £43, 11s. 8d.

£	s.	d.	
43	11	8	
		8	
348	13	4	= value of 8 tons.
10	17	11	= ,, 5 cwt.
8	14	4	= ,, 4 ,,
	10	10⅔	= ,, 1 qr.
£	368	16	5¾ = value of 8 tons 9 cwt. 1 qr.
	400	0	0

5 cwt. = ¼ ton
4 cwt. = ⅕ ,,
1 qr. = 1/16 of 4 cwt.

∴ remainder = £ 31 3 6½ Ans.

3.

4 horses : 6 horses :: 7 mos.

£	s.	d.		£	s.	d.
118	4	3	:	123	16	10
20				20		
2364				2476		
12				12		
28371				29722		
14861				3		

7 mos. × 29722 × 6 / 28371 × 4 = 44583 / 4053 = 11 mos.

4053 | 2

4. 6 men can do 15 boys' work.
1 man ,, 2½ ,,
∴ 4 men ,, 10 ,,

So the question now reads:—'If 6 men, etc. . . . in how many days will 8 men do it?'

8 men : 6 men :: 18 days : 13½ days. Ans.

FEMALES.

1.

		s.	d.		£	s.	d.
49½	stones at	2	8	per stone =	6	12	0
76½	lbs. ,,	0	8	per lb. =	2	11	0
101¼	,, ,,	1	7	,, =	8	0	3¾
20½	,, ,,	3	4	,, =	3	7	6
38½	,, ,,	1	5	,, =	2	14	6¾
177¾	,, ,,	0	9	,, =	6	13	3¾
					£29	18	8 Ans.

2.

	£	s.	d.
	1	17	6
			6
	11	5	0
			8
	90	0	0 = value of 48 cwt.
2 qrs. = ½ cwt.		18	9 = ,, 2 qrs.
1 qr. = ½ of 2 qrs.		9	4½ = ,, 1 qr.
2 lbs. = $\frac{1}{28}$ of 1 qr.			8$\frac{1}{14}$ = ,, 2 lbs.
1 lb. = ½ of 2 lbs.			4$\frac{1}{28}$ = ,, 1 lb.
£	91	9	1$\frac{13}{28}$ = value of 48 cwt. 3 qrs. 3 lbs.

3.

	£	s.	d.
	265408	0	0
		10	
	2654080	0	0 = value of 265408 at £10.
10s. = ½ of £1	132704	0	0 = ,, 10s.
4s. = ⅕ of £1	53081	12	0 = ,, 4s.
6d. = $\frac{1}{8}$ of 4s.	6635	4	0 = ,, 6d.
1½d. = ¼ of 6d.	1658	16	0 = ,, 1½d.
£	2848159	12	0 = value of 265408 at £10, 14s. 1½d.

4.

	£	s.	d.
	24510	0	0
2s. = $\frac{1}{10}$ of £1	2451	0	0 = value of 24510 at 2s.
(Subtract) ¼d. = $\frac{1}{480}$ of 2s.	51	1	3 = ,, ¼d.
£	2399	18	9 = value of 24510 at 1s. 11¾d.

Grammar.

1. ADVERBS AND ADJECTIVES.

no—adj. of quantity qual. *breeze.*
no—adj. of quantity qual. *ripple.*
small—adj. of quality qual. *birds.*
not—adv. of negation modifying *will sing.*
aloud—adv. of manner modifying *will sing.*
springing—adj. verbal, qual. *trout.*
still—adv. of manner modifying *lies.*
so—adv. of degree modifying *darkly.*
darkly—adv. of manner modifying *glooms.*
yon—adj. of distinction pointing out *cloud.*
hidden—adj. verbal, qual. *cloud.*
purple—adj. of quality qual. *shroud.*
distant—adj. of distinction pointing out *hill.*

2. Verbs are divided into two great classes from the manner of forming their past tense.

(1) Verbs which form the *past tense* by a change in the body of the word; as, *give, gave; shine, shone; wring, wrung.* These are called *strong*, and sometimes *irregular* verbs.

(2) Verbs which form the *past tense* by adding *d* (*ed*) or *t* to the *present*; as, *turn, turned; leap, leapt.* These are called *weak*, and sometimes *regular* verbs.

3. POSSESSIVE CASE.

Child's.	Princess's.
Children's.	John's.
Prince's.	James's.

Geography.

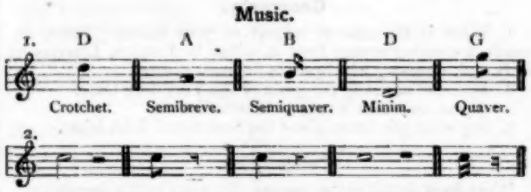
1. Starting from *Portsmouth* (as our nearest seaport) we may remark that it is the first naval station in England. Sailing through *Spithead*—the famous roadstead—we pass *Southampton*, a great packet station, skirt the coast of the *Isle of Wight*, which has been called the garden of England, navigate the channel called the *Solent*, and observe the *Needles*, the termination of the Isle of Wight. The coast now curves round to *Poole Harbour*, south of which is the *Isle of Purbeck* with its limestone known as Purbeck marble. After passing *St. Alban's Head* we reach *Portland Bill*, with excellent building stone, and as we describe the curve round to *Start Point*, we meet with *Lyme Regis, Torbay, Torquay, Dartmouth*, and reach *Plymouth*, noted for its gigantic breakwater, with *Eddystone Lighthouse* to the south. As we continue towards *Lizard Point* we note *Falmouth*, a packet station, and *Mount Bay*, so named from *St. Michael's Mount* situated in it. *Penzance*, noted for its mild climate, lies near *Land's End.* Proceeding north-east, we round *Hartland Point* into *Bideford Bay*, with *Lundy Isle* on our left. Continuing easterly we reach *Bristol*, the fourth seaport of England; then coasting the north side of the *Bristol Channel*, we arrive at *Cardiff*, the chief mineral port of South Wales, and westwards we visit *Swansea* on Swansea Bay, *Caermarthen Bay*, and *Pembroke* on Milford Haven, one of the finest harbours in Britain. Passing St. Bride's Bay and round St. David's Head, we coast the curving line of *Cardigan Bay*, with *Cardigan, Aberystwith, Barmouth*, and *Harlech.* Doubling the peculiar peninsula of *Caernarvon* we come to *Caernarvon Bay*, and enter *Menai Straits*, which divides the *Isle of Anglesea* from the mainland. We cannot but note the suspension and tubular bridges which span the strait. *Bangor*, near the bridges, has beautiful scenery; and farther south is *Caernarvon*, with the castle in which the first Prince of Wales was born. Rounding *Great Ormé's Head* we pass the *Mouth of the Dee*, on which stands *Chester*, a very interesting town, and enter the *Mersey*, on which stands *Liverpool*, perhaps the first port in the world. Opposite this city is *Birkenhead*, with magnificent docks.

2. The *Ouse* and its branches water the plain which lies between the Yorkshire Moors and the Pennine Range. Among the moorlands of the Pennines rise two rivers, the *Swale* and the *Ure*, eventually uniting to form the Ouse, which continues in a south-easterly direction, and receives the *Nidd*, one of three rivers coming from the same region as the parent streams. The other two are the *Wharfe* and the *Aire.* Thus five rivers flow into the Ouse on the right bank, and these rise in the same district of the Pennine Range. On the left bank the river receives only one stream, the *Derwent*, rising in the Yorkshire Moors. The seventh tributary of the Ouse is the *Don*, which, coming from its source in the southern extremity of the Pennine Chain, flows in a north-easterly course to join the Ouse nearly at the junctions of the Aire and the Derwent.

3. The lakes of Scotland, for the most part, are gathered into its *western* half, where, cooped in by long narrow glens, they take almost the form of rivers, being generally many miles in length and scarcely one in breadth. In the northern Highlands north-west of Glenmore, which is itself occupied by a chain of lochs, the lakes are ranged in almost parallel lines from Loch Shin southwards. But the most beautiful of the Scottish lakes lie in the west of the shires of Inverness, Argyle, and Perth, where among the group of the Grampian Peaks the lakes are ranged similarly to the Cumbrian system of England, namely radiating outward like the spokes of a wheel.

The greater number of the Irish lakes extend over that half of the island which lies north-west of a line drawn from Belfast Lough to Kenmare river. In this respect Ireland resembles the Highlands of Scotland; but the Irish lakes differ very much from those of Scotland in their distribution and relation to each other, for instead of radiating from a centre, they form long chains of water joined to one another by connecting rivers.

Music.



3. Five tones and two semitones, the latter being found between the third and fourth, and seventh and eighth notes.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Find the value of $\frac{(1+\frac{1}{3}+\frac{2}{5}+\frac{3}{7})\times(1\frac{4}{5}-\frac{3}{10})}{2\times 10\frac{1}{2}}$ of £1·6.

2. £4$\frac{1}{16}$ is charged for 3·6 yards of velvet,—how much should I have left of £50 after paying for 32·88 yards of the same sort?

3. I receive 2·4 guineas and £·416, and pay from this amount 18·75 half-crowns and ·3571428 of a guinea. What vulgar fraction of a £ have I still in hand?

4. A grocer, who had bought a small chest of tea, kept $\frac{1}{10}$ of ·94 of it for himself, and sold the remainder = 26·25 lbs. What was the original weight of tea in the chest?

FEMALES.

1. A person owes £1537, 3s. 4d., but can pay only £960, 14s. 7d.; what will be the dividend, and how much shall I receive for a debt of £276, 11s. 6d.?

2. A field of 16 acres produces 440 bushels of wheat; how much is that upon every 22 sq. yds.?

3. If 5 men can reap a field whose length is 800 ft. and breadth 700 in 3½ days of 14 hours each, in how many days of 12 hours each can 7 men reap a field whose length is 1800 ft. and breadth 960?

4. If 15 men eat 13 shillings worth of bread in 7 days, when wheat is 12 shillings a bushel, what should be the price so that 10 men should be furnished for 12¼ days at the same cost?

Grammar.

1. 'Habits early engrafted on children—of regular attention, of steady application to what they are about, of prompt obedience to the directions they receive, of cleanliness, order, and modest behaviour—cannot but be of advantage to them in after life, whatever their station may be.'—WHATELY'S *Annotations on Bacon.*

(*a*) Point out and parse all the pronouns and prepositions in the above.

(*b*) What is a defective verb? Give examples from the above, and point out the manner in which such verbs are used.

2. What is the difference between prepositions and conjunctions?

Geography.

Answer *either* Q. 1 *or* Q. 3, *not both.*

1. What is the nearest seaport to your home? Trace, in words, a coasting voyage from it *either* to London, Liverpool, or Newcastle-on-Tyne, choosing whichever of the three is the most distant.

2. Draw a map of the coast from the head of the Gulf of Bothnia to the north-eastern corner of Russia in Europe.

3. Describe fully, as to children, the chief objects of interest to a traveller in Switzerland.

History.

1. Write down the names and dates of our sovereigns from Edward the Confessor to Henry II.

2. Which of the Plantagenet kings were called Lion-heart, Longshanks, and Crook-back? Give their dates, and name their immediate predecessors.

3. A list of English sovereigns from Edward IV. to Charles I.

Penmanship.

Write, in large hand, as a specimen of copy-setting, the word *Burglary.*

Write, in small hand, as a specimen of copy-setting, '*Now, Warwick, tell me, is Edward your true king?*'

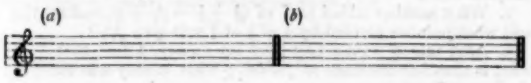
Composition.

Write from memory the substance of the passage read to you by the Inspector.

Music.

A quarter of an hour allowed for this paper.

1. Write in (*a*) the scale of D (*Re*), and in (*b*) the scale of B♭ (*Se*), placing a sharp or a flat before each note requiring one. Mark the places of the semitones.



2. Place its third over (*a*), its fifth over (*b*), its fourth over (*c*), its second over (*d*), and its seventh over (*e*).

3. How many minims are equal (in length) to one semibreve? How many crotchets are equal (in length) to one minim? How many quavers are equal (in length) to a dotted crotchet?

ANSWERS.—FIRST YEAR.

Arithmetic.

MALES.

1. $$\frac{(1+\frac{1}{2}+\frac{1}{3}+\frac{2}{3})\times(\frac{4}{15}-\frac{1}{10})}{2\times 10\frac{5}{8}} = \left\{\left(\frac{12+6+8+9}{12}\right)\times\left(\frac{16-9}{60}\right)\right\}\div\frac{196}{9}$$
$$= \frac{35\times 7\times 9}{12\times 60\times 196} = \frac{1}{64}.$$
And $\frac{1}{64}$ of £1·6 = 384d. $\times\frac{1}{64}$ = 6d. Ans.

2. 3·6 yards cost £4·1$\frac{1}{6}$;
∴ 32·88 yards cost £$4\cdot1\frac{1}{6}\times\frac{32\cdot88}{3\cdot6}$,
32·88 yards cost £$\frac{75\times 32\cdot88}{16\times 3\cdot6}$,
32·88 yards cost £42, 16s. 3d.;
∴ we have (£50—£42, 16s. 3d.), or £7, 3s. 9d. remaining.

3. (*a*) 2·$\dot{3}$ guineas = £$\frac{20\times 21}{9\times 20}$ = £2$\frac{1}{3}$
·41$\dot{6}$ of £1 = £$\frac{5}{12}$ = $\frac{7}{12}$
Total received, £2$\frac{3}{4}$

(*b*) 18·75 half-crowns = £$1\frac{7}{8}\times\frac{1}{2}$ = £$2\frac{1}{16}\frac{1}{2}$ = £$2\frac{1}{16}$
·3571428 of 21s. = £$\frac{5}{16}\times\cdot3\frac{5}{7}$ = $\frac{5}{16}$ = $\frac{5}{16}$
Total paid away = £$2\frac{3}{4}\frac{3}{16}$
∴ the vulgar fraction of £1 remaining
= (£$2\frac{3}{4}^4 - 2\frac{3}{4}\frac{3}{16}$) = £$\frac{13}{16}$. Ans.

4. $\frac{9}{136}$ of ·94 = $\frac{9\times 85}{136\times 90} = \frac{1}{16}$;
∴ $\frac{15}{16}$ of whole = 26¼ lbs.,
or $26\frac{1}{4}\times\frac{16}{15} = \frac{105\times 16}{4\times 15}$ = 28 lbs. Ans.

FEMALES.

1. (*a*)

£	s.	d.	£	s.	d.	£	
1537	3	4	960	14	7	1	: dividend.
20			20				
30743			19214				
12			12				
368920d.			230575d.				

$\frac{20s.\times 230575}{368920}$ = 12s. 6d. 1st Ans.

(*b*) £276, 11s. 6d. at 12s. 6d. per £ =

£	s.	d.	
276	11	6	
138	5	9	= dividend at 10s. in £.
34	11	5½	= „ 2s. 6d. in £.
172	17	2½	= „ 12s. 6d. in £.

2d Ans. = £

2. Square yards in 16 acres = 4840 × 16;
∴ 22 square yards produce 440 bushels $\times\frac{22}{4840\times 16}$
„ „ 440 bushels $\times\frac{1}{3520}$
„ „ ⅛ bushel. Ans.

3. 800 feet : 1800 feet :: 3½ days,
700 feet : 960 feet,
12 hrs. : 14 hrs.,
7 men : 5 men.
$\frac{7\text{ days}\times 5\times 14\times 960\times 1800}{2\times 7\times 12\times 700\times 800}$ = 9 days.

4. 10 men : 15 men :: 12s.
12½ days : 7 days.
$\frac{12s.\times 7\times 15\times 4}{10\times 49}$ = 10$\frac{2}{7}$s. Ans.

1. (*a*) **Grammar.**

on—prep. connecting *children* with *act implied by engrafted.*
of—prep. ,, *attention* with *habits.*
of—prep. ,, *application* with *habits.*
to—prep. ,, *that* (expressed in *what*) with *application.*
about—prep. ,, *which* (expressed in *what*) with *state of being.*
of—prep. ,, *obedience* with *habits.*
to—prep. ,, *directions* with *obedience.*
of—prep. ,, *cleanliness, order, behaviour,* with *habits.*
of—prep. ,, *advantage* with *the state of being.*
to—prep. ,, *them* with *advantage.*
in—prep. ,, *life* with *advantage.*
what—rel. pron. (equivalent to *that which*). *That*, obj. case gov. by *to; which*, obj. case gov. by *about.*
they—pron. personal, 3d person plu. com. gender, nominative case, subj. of *are.*
they—(same as above) subj. of *receive.*
them—pron. personal, 3d pers. plu. com. gen. obj. case, gov. by *to.*
their—pronom. possessive adjective = possess. of *they.*
whatever—indefinite adj. pronoun, neut. nom. case, subj. of *may be.*

(*b*) A defective verb is one which wants some of its parts. The defective verbs in the given passage are *can* and *may.* They are used as auxiliaries to other verbs, the verb following them being in the infinitive mood, with the sign *to* omitted. The full expression in the passage is *cannot but* (*to*) *be, whatever their station may* (*to*) *be.*

2. Prepositions sustain towards single words the same relation which conjunctions sustain towards sentences. The word governed by the preposition always forms a phrase equivalent to an adverb, or a qualifying phrase equivalent to an adjective. With the conjunction, such a modifying or qualifying phrase could not be made.

Geography.

1. *See same question answered under Candidates in this number of the Magazine.*

3. CHIEF OBJECTS OF INTEREST IN SWITZERLAND.

(1) *Mountains and Valleys.*—Switzerland is altogether a mountainous country, two-thirds of its surface consisting of lofty mountain chains and Alpine valleys. The remainder is a high plain, elevated about thirteen hundred feet above the level of the sea. All the higher ranges of the Alps rise above the snow-line, and the immense quantities of snow collected on their summits are being continually dashed down their sides into the valleys below, where they often cause great devastation, sweeping trees and rocks before them, turning the courses of streams, and burying whole villages with all their inhabitants. These falls of snow are called *avalanches*, the distant noise of which is heard like the rolling of thunder, and warns the villagers of their approach. Sometimes *land-slips* occur, when large masses of earth and rocks are torn from the mountain-sides and dashed into the valleys.

(2) *Rivers.*—The numerous mountain-torrents of Switzerland form cataracts, and many of these are famed for their beauty. One of the most celebrated is that called the *Staubbach*, on a branch of the Aar, which is 800 feet high, and probably the loftiest cascade in Europe. The falls of the Rhine below *Schaffhausen* are also much celebrated.

(3) *Animals.*—Among native animals, the *ibex* and the *chamois* are the most characteristic. The Alpine *marmot*, too, is very interesting, forming among the mountains families which burrow underground and spend the winter in a state of lethargy. Of domestic quadrupeds, every one has heard of the famous breed of Alpine spaniels kept by the monks of St. Bernard, which display such wonderful sagacity in rescuing travellers from the snow. The convent of St. Bernard, situated 7963 feet above the sea, is near the summit of the mountain pass, and in a region where numerous avalanches occur. These dogs are trained to seek travellers who may have lost their way, being furnished with a basket of provisions fastened round the neck. Many stories have been written about these dogs.

(4) *People.*—As the soil seems by nature designed for feeding cattle, the cows, goats, and sheep are the wealth of the Swiss farmer. In summer the cattle go to the mountains for pasture, when the herdsmen live in rude huts or *chalets*, where cheese and butter are made. In winter the cattle return to the lower grounds. The making of watches, musical boxes, and jewellery is an especial characteristic of the Swiss. Education is in a very advanced state, elementary instruction being spread among all classes, and their methods of teaching have furnished models for imitation in all parts of Europe.

History.

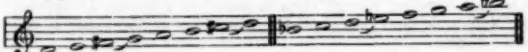
			A.D.
1.	Edward the Confessor	began to reign	1042
	Harold II.	,,	1066
	William the Conqueror	,,	1066
	William Rufus	,,	1087
	Henry I.	,,	1100
	Stephen	,,	1135
	Henry II.	,,	1154

2. Richard I. (Lion-heart) began to reign 1189 A.D.; was succeeded by John.
Edward I. (Longshanks) began to reign 1272 A.D.; was succeeded by Edward II.
Richard III. (Crook-back) began to reign 1483 A.D.; was succeeded by Henry VII.

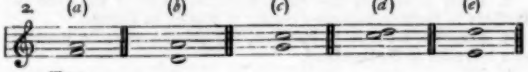
			A.D.
3.	Edward IV.	began to reign	1461
	Edward V.	,,	1483
	Richard III.	,,	1483
	Henry VII.	,,	1485
	Henry VIII.	,,	1509
	Edward VI.	,,	1547
	Mary	,,	1553
	Elizabeth	,,	1558
	James I.	,,	1603
	Charles I.	,,	1625

Music.

1. (*a*) (*b*)



2. (*a*) (*b*) (*c*) (*d*) (*e*)



3. Two.
Two.
Three.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Arithmetic.

MALES.

1. At what rate per cent. per annum will the simple interest on £1043, 15s. amount to £121, 15s. 5d. in $2\frac{1}{8}$ years?

2. What sum lent for 125 days at $6\frac{2}{3}$ per cent. per annum will give £10, 9s. $3\frac{1}{2}$d. interest?

3. Share £150 among A, B, C, D, so that A may have $11\frac{1}{9}$ per cent. of it, B $5\frac{5}{9}$ per cent. of it, C $33\frac{1}{3}$ per cent. of it, and D the remainder of the money. How much will each receive, and what percentage of the whole will fall to D?

4. Find the difference between the simple and compound interest on £360 for 3 years at 5 per cent. per annum.

FEMALES.

1. Reduce the expression $\left(\frac{3\frac{1}{2}}{7}+\frac{2}{10\frac{1}{2}}-\frac{5}{18}\text{ of }\frac{4}{7}\right)\times 1\frac{3}{4}$ to its simplest form.

2. What number added to $\frac{2}{3}$ of $(\frac{1}{2}+\frac{1}{3}-\frac{1}{12}+\frac{1}{4})$ makes $3\frac{1}{4}$; and what number divided by $\frac{1}{4}$ of $\frac{1}{3}$ of $\frac{1}{6}$ will give $\frac{44}{315}$?

3. After taking from a bag $\frac{1}{4}$ of my money, I find that $\frac{3}{5}$ of what is then left amounts to 7s. 6d.; what money was there in the bag at first?

4. What part of $\frac{1}{3}$ of a ton is $2\frac{3}{5}$ of $1\frac{1}{3}$ of $\frac{1}{7}$ of a cwt.?

Grammar.

1. 'Men were meant to fill the earth and to conquer it, as they are doing at this day. They were meant to become hardy and industrious, to be forced to use their hands and their heads to the utmost stretch, to call out into practice all the powers which lay ready in them.'

(*a*) Point out the extensions of the predicate that occur in the above passage.

(*b*) Point out and parse all the participles and verbs in the infinitive mood that occur in the above, and show in what important respect they differ from finite verbs.

(*c*) What kind of sentence is that in the above, which is joined to the principal sentence by the conjunction 'as'? Give other examples of like sentences.

Geography.

Answer *either* Question 1 *or* Question 2, *not both*.

1. Give notes of a lesson on 'The chief objects of interest to a traveller in Switzerland.'

2. Describe fully the physical features and general character of Natal, New Zealand, Labuan, Hong Kong, Mauritius, and St. Helena.

3. Draw a full map of the Bay of Bengal.

SECOND PAPER.

One hour allowed for Females, two and a half for Males.

History.

1. How was the Witena-gemôt composed? and what were its powers?

2. Give the names of Henry the Second's wife and sons, and their conduct towards him.

3. Who was the Queen of Edward IV.? Mention the names, titles, and fate of her sons.

Penmanship.

Write, in large hand, as a specimen of copy-setting, the word *Burglary*.

Write, in small hand, as a specimen of copy-setting, '*Now, Warwick, tell me, is Edward your true king?*'

Composition.

Write full notes of a lesson on *Clouds and their uses*.

Euclid.

[All generally-understood abbreviations for *words* may be used, but no symbols of *operation*, such as —, +, ×, are admissible.]

1. Define *plane angle, circle, rhombus, axiom*. When are two magnitudes said to be equal to one another?

2. From the greater of two given straight lines to cut off a part equal to the less.

What are the *data* and what are the *quæsita* in this problem?

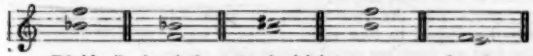
3. If two straight lines cut one another, the vertical or opposite angles shall be equal.

State, and work out, the corollaries.

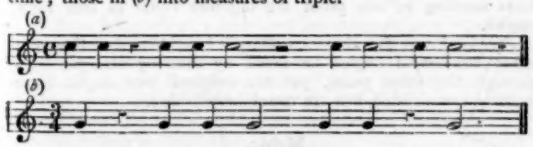
Music.

A quarter of an hour allowed for this paper.

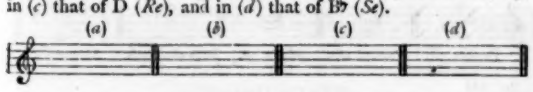
1. Write, under each of the following, the name and quality (major, perfect, or other) of the interval it forms :—



2. Divide (by bars) the notes in (*a*) into measures of common time; those in (*b*) into measures of triple.



3. Write in (*a*) the signature of G (*Sol*), in (*b*) that of F (*Fa*), in (*c*) that of D (*Re*), and in (*d*) that of B♭ (*Se*).



ANSWERS.—SECOND YEAR.

Arithmetic.

MALES.

1. Interest on £1043¾ for $2\frac{1}{12}$ yrs. = £121, 15s. 5d. = 29225d.;

∴ ,, £100 ,, 1 yr. = 29225d. × $\frac{100 \times 4 \times 12}{4175 \times 25}$;

,, ,, ,, ,, = 1344d.;

,, ,, ,, ,, = £5⅗. Ans.

2.

£6¼ would be gained in 365 days by £100;

∴ £10, 9s. 3½d. ,, 125 ,, ,, £100 × $\frac{£10,9s.3\frac{1}{2}d.}{£6\frac{1}{4}} \times \frac{365}{125}$;

,, ,, ,, ,, ,, £100 × $\frac{10045 \text{ far.}}{5880} \times \frac{365}{125}$;

i.e. £498, 16s. 8d. Ans.

3.

		£	s.	d.	
11⅛ p. c. of £150 = $\frac{199}{888}$ of £150 =		16	13	4	A's share,
5⅔ ,, ,, = $\frac{51}{900}$,, =		8	6	8	B's ,,
33⅓ ,, ,, = $\frac{300}{900}$,, =		50	0	0	C's ,,

D's share is therefore £75, or 50 per cent. of the whole.

4. (*a*) Simple interest = £360 × $\frac{3 \times 5}{100}$ = £54.

(*b*) Compound interest is found below :—

5 per cent. per annum = $\frac{1}{20}$ of principal.

£	s.	d.	
360	0	0	principal for 1st year.
18	0	0	interest ,,
378	0	0	principal for 2d year.
18	18	0	interest ,,
396	18	0	principal for 3d year.
19	16	10½	interest ,,
416	14	10½	amount for 3d year.
360	0	0	principal at beginning.
56	14	10½	compound interest.
54	0	0	simple ,,
£2	14	10½	Ans. difference required.

FEMALES.

1. The next form of the expression is

$$\left(\frac{10}{21}+\frac{4}{21}-\frac{10}{63}\right)\times\frac{7}{4}$$

$$=\frac{30+12-10}{63}\times\frac{7}{4}=\frac{32\times7}{63\times4}=\frac{8}{9}.$$ Ans.

2. (*a*) The next form of the expression is

$$4\frac{13}{4}-\frac{3}{4}\times\left(\frac{15+9-12+5}{45}\right)$$

$$=\frac{13}{4}-\frac{3\times17}{4\times45}=\frac{13}{4}-\frac{17}{60}$$

$$=\frac{195-17}{60}=2\frac{29}{30}.$$ Ans.

(*b*) $\frac{64}{315}\times\frac{1}{4}$ of $\frac{1}{6}$ of $\frac{1}{8}$

$$=\frac{64}{315\times4\times6\times8}=\frac{1}{945}.$$ Ans.

3. By taking away ⅓ there remains ⅔.

Now ⅔ of ⅔ = 7s. 6d.,

or ⅓ = 7s. 6d.;

∴ the whole must be 15s. Ans.

4. $\frac{2\frac{2}{3} \text{ of } 1\frac{1}{3} \text{ of } \frac{1}{4} \text{ cwt.}}{\frac{1}{3} \text{ ton}} = \frac{\frac{8}{3}\times\frac{4}{3}\times\frac{1}{4} \text{ cwt.}}{6\frac{2}{3} \text{ cwt.}}$

$$=\frac{8\times4\times1\times3}{3\times3\times7\times20}=\frac{8}{105}.$$ Ans.

Grammar.

1. (*a*) The extensions of the predicate are :—(1) *to fill the earth* (*as they are doing at this day*); (2) *to conquer it, as they are doing at this day*; (3) *to become hardy and industrious*; (4) *to be forced to use their hands and heads to the utmost stretch*; (5) *to call out into practice all the powers which lay ready in them*.

(*b*) *meant*—trans. verb, complete part. strong conj. (*mean, meant, meant*), agreeing with *men*.

to fill—trans. verb, infinitive mood, pres. indef. tense, weak conj. gov. by *meant*.

to conquer—trans. verb, infin. mood, pres. indef. tense, weak conj. gov. by *meant*.

doing—verb, incomplete part. strong conj. (*do, did, done*), agreeing with *they*.

meant—trans. verb, complete part. strong conj. (*mean, meant, meant*), agreeing with *men*.
to become—intrans. verb, infin. mood, pres. indef. tense, strong conj. (*become, became, become*), gov. by *meant*.
to be—verb, incomplete, infin. mood, pres. indef. tense, conj. *am, was, been*, gov. by *meant*.
forced—trans. verb, complete part. weak conj. agreeing with *they*.
to use—trans. verb, infin. mood, pres. indef. tense, weak conj. gov. by *forced*.
to call out—compound trans. verb, infin. mood, pres. indef. tense, weak conj. gov. by *meant*.

The *infinitive mood* differs from the *finite* verb in making no statement whatever, but simply setting before the mind the notion expressed by the verb.

(*c*) The sentence beginning with 'as' is a *subordinate adverbial sentence*. Other sentences are:—Do as *you are bid*. Come *when he tells you*. He went away *while you were speaking*.

Geography.

1. *See same question fully answered under First Year in this number of Magazine.*

2. *Natal.*—The country rises in three terraces towards the mountains. The first lies along the shore, is highly fertile, and is tropical in climate and vegetation. The second rises 800 feet high; and the third is divided into (1) *Midlands*, yielding the produce of South Europe; and (2) *Uplands*, which portion has a climate and productions very similar to our own. The *Drakenberg Mountains* are the chief. The rivers are numerous, but none of them navigable to any extent. The largest is the *Tugela*, which, with its tributary the Buffalo, forms the northern boundary.

New Zealand.—The coast-line of North Island is remarkable for the very numerous inlets it contains. South Island is but little indented except at its northern end. New Zealand may be called a wooded highland country, clothed with a luxuriance of vegetation. The centre of North Island is occupied by broad and lofty mountains, which send off spurs to the sea-coast. South Island is traversed its entire length by a mountain range, which runs nearer the western than the eastern coast. North Island is very volcanic in character, and three distinct lines of craters occur in it. There are numerous rivers, but these are for the most part small. One of the most striking features of the colony is the abundance of water and water-power. The river valleys, at first narrow and confined, open out, as the rivers approach the sea, into broad fertile districts.

Labuan.—This island is well supplied with water, has a good harbour at Victoria, and abounds in excellent coal. Edible birds'-nests, a luxury of the Chinese, are exported from this island.

Hong Kong.—This island consists of barren granite rocks, rising to a height of one or two thousand feet. Water is abundant, and the climate, though warm, is considered healthy. Its capital, Victoria, stands on a splendid harbour.

Mauritius.—This is an oval-shaped island, evidently of volcanic origin. The interior contains numerous hills and mountains, mostly occurring as short isolated ridges. Fertile plains and valleys are abundant, watered by streams which become periodically dry. The climate, though damp, is healthy, but the island is exposed at times to most terrific hurricanes, which do great damage.

St. Helena.—This small island forms towards the sea a wall of precipitous cliffs, intersected by chasms which open into narrow valleys, leading up to the table-land in the centre. The climate is one of the healthiest within the tropics. It is not too warm, as there is always a good breeze, the island lying in the strength of the south-east trade-wind.

History.

1. By right every freeman was a member of the Witena-gemôt, or assembly of the wise. Latterly, when the kingdom grew in extent, it was attended only by the Ealdormen, who were something like viceroys. The powers of the Witan were large. It could elect or depose the king, it dealt with higher justice, imposed taxes, made laws, concluded treaties or declared war, disposed of the public lands, and appointed the great officers of state.

2. Henry II. married Eleanor, the divorced queen of Louis VII. of France, and his sons were Henry, Richard, Geoffrey, and John, who, urged on by their mother, rebelled against their father to dethrone him.

3. The queen of Edward IV. was Elizabeth Woodville, daughter of Lord Rivers, and widow of Sir John Grey. Her sons were Edward V. and Richard, Duke of York. They were *murdered* in the Tower, it was said, by the orders of their uncle, Richard III., who had usurped the crown.

Composition.

NOTES OF A LESSON ON CLOUDS.

Evaporation.—From every exposed piece of water warmed by the sun there is rising an invisible watery vapour, slowly and quietly, into the atmosphere. This process called *evaporation*. Call attention to the boiling of water, and steam issuing from spout of a kettle, steam invisible close to spout.

Condensation.—So long as vapour remains heated it is invisible; whenever laden air becomes sufficiently cooled, its burden of moisture makes its appearance as a *cloud*. Call attention to clouds of steam from spout of kettle or from funnel of engine.

Rain.—If the cooling (or condensation, as it is called) continues, the cloud descends in the form of rain. Call attention to fogs, which are clouds close to the ground—hail—snow.

Forms of Clouds.—White and fleecy, sometimes curled like feathers; these very far up. Dense and heaped up; again extending in continuous sheets. Sometimes clouds of different forms intermingle. Call attention to appearance of clouds while giving lesson.

Uses of Clouds.—No clouds no rain. Call attention to deserts; scarcity of water; the value of rain in some parts of India and Africa; effects of drought; the cool screen that clouds make in summer for tender plants which the sun might shrivel up; the pleasure to be got from watching their shapes. Clouds may be studied to get a knowledge of probable weather.

Euclid.

1. A *plane angle* is the inclination of two lines to each other in a plane, which meet together, but are not in the same direction.

A *circle* is a plane figure contained by one line which is called the circumference, and is such that all straight lines drawn from a certain point (called the centre) within the figure to the circumference are equal to one another.

A *rhombus* is a four-sided figure which has all its sides equal, but its angles are not right angles.

An *axiom* is a theorem, the truth of which is admitted without proof.

Two magnitudes are said to be equal to one another when they coincide with one another—that is, when they exactly fill the same space.

2. Prop. 3, Book 1.

Data, two straight lines of unequal length. Quæsita, cutting off a part equal to the less.

3. Prop. 15, Book 1.

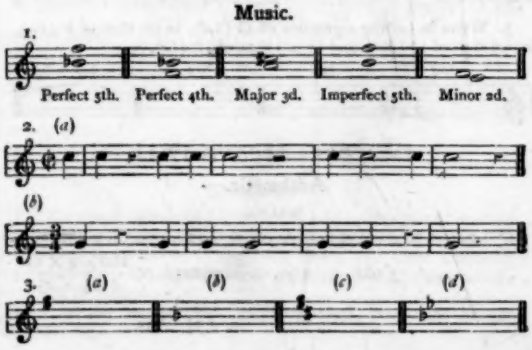
First Corollary.—If two straight lines cut one another, the angles which they make at the point where they cut are together equal to four right angles.

Proof.—For the two angles on each side of one line are together equal to two right angles (Prop. 13), and therefore the four are together equal to four right angles.

Second Corollary.—All the angles made by any number of lines meeting in one point are together equal to four right angles.

Proof.—From the above corollary it is evident that though a great number of angles be made by drawing straight lines through the same point, yet the original four angles have nothing more added, but are merely subdivided.

Music.



THIRD YEAR.

Pupil Teachers at end of Third Year, *if apprenticed on, or after,* **1st *May* 1878; and Pupil Teachers at end of Fourth Year, if apprenticed before that date.**

FIRST PAPER.

Three hours and a half allowed.

Arithmetic.

MALES.

1. To what sum will £480 amount, in 3 years, at 5 per cent. per annum compound interest?

2. By selling 5505½ articles at a profit of 66·6 per cent., I made a clear gain of £2385, 14s. 4d. What did the articles cost me per score?

3. If the rent of a farm of 17 ac. 3 ro. 2 po. be £39, 4s. 7d., what would be the rent of another farm containing 26 ac. 2 ro. 23 po. if 6 acres of the former be worth 7 acres of the latter?

4. A has to perform a journey of 46 miles, which he can do in 10 hours; B can do the same in 13 hours. If they are started at the same moment from opposite ends of the journey and walk towards each other, in how many hours will they meet, and what number of miles will each travel?

FEMALES.

1. Divide 1121·4 by ·534, and 172·9 by ·142 to three places of decimals.

2. Find the value of ·375 of a guinea + ·34 of 8s. 3d. + ·01½ of £2, 15s.

3. Find the value of $\frac{133}{400}$ of $3\frac{9}{11}$ tons − ·340⅝ of $1\frac{3}{5}$ qrs. + $\frac{\cdot 213348}{\cdot 326}$ of 2 cwt. 102 lbs.

Grammar.

1. 'Impostor! do not charge most innocent Nature,
As if she would her children should be riotous
With her abundance; she, good cateress,
Means her provision only to the good,
That live according to her sober laws,
And holy dictate of spare temperance.'
MILTON'S *Comus.*

(*a*) Analyse the principal sentences in the above.
(*b*) What is meant by words being 'in apposition'? Point out any example of this construction that you notice in the above.
(*c*) Give the meaning of the above passage in your own words.
(*d*) Parse all the words in the first two lines.

2. What are the Latin prepositions that mean *under, with?* Give examples of words compounded with them, and show how the spelling of these prepositions varies in *composition.*

Geography.

Answer *either* Q. 2 *or* Q. 3, *not both.*

1. Give full notes of a lesson on this sentence in a letter from a young man in Ceylon:—
'I have just returned to this island from a coasting voyage round the Bay of Bengal, in which I have carefully examined every seaport, the mouth of every river, and have studied the general character of the country on each side of the Bay.'
Draw a map in illustration.

2. Describe a journey by land from the mountains of Abyssinia to Jerusalem.

3. Describe, in order, the rivers flowing into the Indian Ocean and its branches.

SECOND PAPER.

One hour allowed for Females, two and a half for Males.

History.

1. Tell the names and fate of the wives of Henry VIII.

2. What was the condition of the Netherlands in the time of Elizabeth? Describe the part taken by England, and tell what you know about Sir Philip Sidney.

3. When and under what circumstances did (*a*) Wales, (*b*) Scotland, and (*c*) Ireland first send members to the English Parliament?

Penmanship.

Write, in large hand, as a specimen of copy-setting, the word *Burglary.*

Write, in small hand, as a specimen of copy-setting, '*Now, Warwick, tell me, is Edward your true king?*'

Composition.

Write from memory the substance of the passage read to you by the Inspector.

Euclid.

[All generally-understood abbreviations for *words* may be used, but symbols of *operations,* such as −, +, ×, are not admissible.]

1. In the base BC of a triangle ABC any point D is taken. Draw a straight line such that if the triangle ABC be folded along this straight line, the point A shall fall upon the point D.

2. If a straight line falling upon two other straight lines, make the exterior angle equal to the interior and opposite upon the same side of the line; or make the interior angles upon the same side together equal to two right angles; the two straight lines shall be parallel to one another.

3. Parallelograms upon the same base, and between the same parallels, are equal to one another.
Are the parallelograms equal in all respects?

Algebra.

1. Simplify $1\frac{1}{3} - \frac{3}{4}\{1 - \frac{2}{3}(x - \frac{1}{2})\}$, and cube the result.

2. Reduce to lowest terms $\frac{x^3 + x - 12}{x^3 - 5x^2 + 7x - 3}$.

3. Solve the equations:—

(1) $\frac{1}{2}(9 - 2x) = \frac{3}{2} - \frac{7x - 18}{10}$.

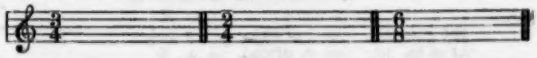
(2) $\frac{13 + 6x}{15} - \frac{2x}{5} = \frac{3x + 5}{5x - 25}$.

Music.

A quarter of an hour allowed for this paper.

1. Complete the following (by inserting the necessary sharps or flats) as a descending and ascending diatonic minor scale of C (*Do*). Mark the places of the semitones:—

2. Write a measure, of rests only, in each of the kinds of time indicated by the following signatures:—



3. Write over each of the following the name of the major scale, and under each that of the minor scale, of which it is the signature:—

ANSWERS.—THIRD YEAR.

Arithmetic.

MALES.

1.

5 p. c. per annum = $\frac{1}{20}$ of principal.

£	s.	d.	
480	0	0	principal for 1st year.
24	0	0	interest ,,
504	0	0	principal for 2d year.
25	4	0	interest ,,
529	4	0	principal for 3d year.
26	9	2½	interest ,,
£555	13	2½	amount. Ans.

2. 66·6 per cent. $= \frac{66\frac{2}{3}}{100} = \frac{2}{3}$;

$\therefore$ prime cost $= £2385, 14s. 4d. \times \frac{3}{2}$;

" $= £3578, 11s. 6d.$;

$\therefore$ 1 score cost $£3578, 11s. 6d. \times \frac{20}{5505\frac{1}{2}}$,

i.e. $£\frac{143143}{11011}$,

i.e. £13. Ans.

3. Rent required $= £39, 4s. 7d. \times \frac{26 ac. 2 ro. 23 po.}{17 ac. 3 ro. 2 po.} \times \frac{7}{6}$,

" $= £39, 4s. 7d. \times \frac{4263 po.}{2842 po.} \times \frac{7}{6}$,

" $= £39, 4s. 7d. \times \frac{7}{4}$,

" $= £68, 13s. 0\frac{1}{2}d.$ Ans.

4. (*a*) A performs $\frac{1}{10}$ of the journey in 1 hour or $\frac{13}{130}$.
B " $\frac{1}{13}$ " " " or $\frac{10}{130}$;
$\therefore$ by starting from different ends, A performs 13 parts of the journey, while B does 10, or together they perform 23 parts.
$\frac{13}{23}$ of 46 miles = 26 miles for A. Ans.
$\frac{10}{23}$ " = 20 " B. Ans.

(*b*) They will meet in the time taken by A to travel 26 miles, or time taken by B to travel 20 miles.
If A travels 46 miles in 10 hours, he will travel 26 miles in $10 \text{ hrs.} \times \frac{26}{46} = 5\frac{13}{23}$ hrs. Ans.

FEMALES.

1. (*a*)

$$\cdot534\overline{)1121\cdot411}\,(2100. \text{ Ans.}$$
1068
534
534

(*b*)

$$\cdot142\overline{)172\cdot9}\,(1217\cdot605. \text{ Ans.}$$
142
309
284
250
142
1080
994
860
852
800
700

2.

		s.	d.
·375 guinea	$= \frac{3}{8}$ of 21s.	= 7	$10\frac{1}{2}$
·04 of 8s. 3d.	$= \frac{4}{100}$ of 99d.	= 4	6
·01$\frac{1}{2}$ of £2, 15s.	$= \frac{1}{110}$ of 55s.	= 1	6

By addition, 13 $10\frac{1}{2}$ Ans.

3.

	tons	cwt.	qrs.	lbs.
$\frac{133}{400}$ of $3\frac{3}{4}$ tons $= \frac{15}{4}$ tons $\times \frac{133}{400}$ =	1	4	3	21
·340$\frac{4}{5}$ of $1\frac{2}{3}$ qrs. $= \frac{5}{3}$ qrs. $\times \frac{63}{185}$ =				$15\frac{33}{37}$
By subtraction,	1	4	3	$5\frac{4}{37}$ = 1800/16650

·213348/·326 of 2 cwt. 102 lbs.
= 326 lbs. $\times \frac{·213348}{·326}$
= 1000 lbs. $\times$ ·213348
= 213·348 lbs. = 1 3 $17\frac{157}{450}$ = 5809/16650

By addition, 1 6 2 22 7609/16650

Grammar.

1. (*a*)

Principal Sentence.	Subject and Enlargement.	Predicate.	Object and Enlargement.	Extensions.
(1) Impostor! do not charge most innocent Nature.	(*Thou*) impostor!	do not charge	most innocent Nature	...
(2) She, good cateress, means her provision only to the good.	She, good cateress,	means	her provision	only, to the good (*dative object*)

(*b*) By words in 'apposition' are meant nouns or pronouns which are attached to other nouns or pronouns without any connective, and refer to the same person or thing. The second word is said to be in 'apposition' with the former, and agrees with it in case; as, Impostor! (*thou*) (voc.); she, *good cateress*.

(*c*) You deceiver! would you groundlessly accuse Nature of desiring men to wantonly consume the luxuries which she has unsparingly bestowed on them? Far from being guilty of such a wish, she, like a thrifty provider, intends her good things only for the prudent, who use them according to the laws of temperance and sobriety.

(*d*) *Impostor*—noun, masc. gen. sing. num. voc. case (nom. of address).
do not charge—trans. verb, emphat. neg. form, imperative mood, weak conj. 2d pers. sing. agr. with (*thou*).
most—adverb of degree, forming with
innocent—the superlative degree of an adj. qual. *Nature*.
Nature—noun (=proper noun), fem. gen. sing. num. obj. gov. by *charge*.
as if—conj. phrase, connecting a subord. sent. with a principal.
she—pers. pron. 3d pers. sing. fem. nom. case, subj. of *would*.
would—defect. verb, subj. mood, past indef. tense, 3d pers. sing. agreeing with subj. *she*.
her—pronom. poss. adjective, qual. *children*.
children—com. noun, com. gender, plu. num. nom. case, subj. of *should be*.
should be—verb, incomplete (*am, was, been*), subjunctive mood, pres. indef. tense, 3d pers. plu. agreeing with subj. *children*.

NOTE.—*Should be* is periphrastic, and equivalent to 'be.'

2. *Sub* is the Latin preposition for 'under,' and takes in composition the forms *suc, suf, sug, sum, sup, sur, sus;* as, *sub*altern, *sub*lime, *suc*ceed, *suf*fuse, *sug*gest, *sum*mon, *sup*plant, *sur*rogate, *sus*pend.

Cum is the Latin preposition for 'with,' and takes the forms *com, col, con, cor, co;* as, *com*bat, *col*lapse, *cor*rect, *co*gnate, *co*-operate.

Geography.

1. NOTES ON BAY OF BENGAL.

Seaports.—Amherst; Moulmein, exports timber, much ship-building; *Martaban; Rangoon*, a most important town, exports teak, well fortified; *Calcutta*, capital of British India, taken by Clive 1757; *Pooree*, also called Juggernaut, from famous Hindoo temple; *Masulipatam; Madras*, situated on a surf-beaten shore—vessels lie in the roads two miles off.

River-mouths.—Saluen; Irrawady has a large delta: Rangoon sits on the only branch that is always navigable; *Brahmapootra*, its lower course may be considered as forming part of the delta of the Ganges; *Ganges*, 300 miles from the sea, begins its lower course, which flows through a peculiar delta, whose uninhabitable marsh, as large as Wales, is called the *Sunderbunds*. The most eastern stream is called *Ganges*, and the western *Hooghly*. *Mahanuddy* has a considerable delta, which forms the province of Cuttack. *Godavery*, chief river of the Deccan, forms a small delta; its port is *Coringa*. *Kistnah* has also a delta; its port is Masulipatam. *S. Pennair*, the French settlement of Pondicherry, stands at its mouth. *Cauvery* forms a very large delta.

General Character of Countries.—British Burmah.—Climate well suited for Europeans; rich in minerals—coal, tin, copper, and limestone; products—cotton, rice, and timber. *Assam.*—

Watered by the Brahmapootra; surface flat; might be the best manufacturing district in India. *Bengal.*—A great alluvial plain. The *Sunderbunds.*—Jungle and marsh; climate tropical; majority of people agricultural; great variety of products. *Madras.*—Greater part artificially irrigated; climate excessively hot; forests extensive and valuable; cinchona plantations in the Neilgherries. *Eastern Ghauts* run comparatively close along the west coast of the Bay.

2. In journeying by land from the mountains of Abyssinia to Jerusalem, the most convenient route will be to follow the *Tacazze*, a tributary of the Nile. Beginning among the mountains, say at the site of *Magdala*, which was taken by the British under Napier in 1868, we follow the Tacazze till it changes into the *Atbara*, the third great tributary of the Nile, the most wonderful river in the world. Following the windings of the river through *Nubia*, we continue our journey along its limited valley, passing the towns of *Berber*, *Dongola*, *Ipsambool*, and *Derr*. Entering *Egypt*, we find that this country depends on the Nile for its fertility. We may visit on our way the interesting ruins of *Thebes*, and the towns of *Kenneh*, *Siout*, *Ghizeh*, and *Cairo*. We may now turn east to the *Suez Canal*, crossing which we strike across the desert, following if we choose the route which the Israelites took in journeying from Egypt to the Holy Land, crossing into *Palestine* by the southern boundary, and arriving at *Jerusalem*, our destination, through the ancient tribe of Judah, visiting those places which have been identified with *Engedi*, *Hebron*, *Bethlehem*, etc.

3. RIVERS.

FLOWING INTO THE INDIAN OCEAN AND ITS BRANCHES.

	River	*Flowing through*	*Direction.*
In Africa.	Limpopo.	Transvaal, Sofala.	East.
	Zambesi.	South Africa.	Easterly.
In Asia.	Euphrates.	Asia Minor.	South.
	Tigris.	,,	,,
	Indus.	India.	,,
	Nerbudda.	,,	West.
	Taptee.	,,	,,
	Cauvery.	,,	East.
	Kristnah.	,,	,,
	Godavery.	,,	,,
	Mahanuddy.	,,	,,
	Ganges.	,,	,,
	Brahmapootra.	,,	East and south.
	Irrawady.	,,	South.
In Australia.	Murray.	Divides N. S. Wales from Victoria.	Westerly.
	Swan.	West Australia.	,,
	Murchison.	,,	,,

History.

1. The wives of Henry VIII. were:—
   (1) Catherine of Aragon—divorced.
   (2) Anne Boleyn—beheaded 1536.
   (3) Jane Seymour—died in child-birth.
   (4) Anne of Cleves—divorced.
   (5) Catherine Howard—beheaded.
   (6) Catherine Parr—survived Henry; married Sir Thomas Seymour.

2. In the time of Elizabeth the people of the Netherlands were in revolt against their sovereign, Philip of Spain. Being Protestants they got assistance from the Queen, who sent an expedition under the command of the Earl of Leicester. The expedition effected nothing, but is memorable for an incident which took place at the battle of Zutphen. In this battle Sir Philip Sidney, who, for his talents as a statesman, soldier, and scholar, was the darling of England, received a wound which proved mortal. While he was raising a bottle to his lips to quench his thirst, he observed a dying soldier look wistfully at it. Without tasting the contents, he handed the bottle to the soldier, saying, 'Thy necessity is yet greater than mine.'

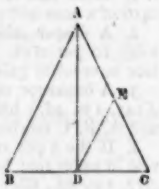
3. (*a*) Wales was incorporated in a legislative union with England (1536) in the reign of Henry VIII., and the English laws and liberties were granted to the inhabitants.

(*b*) Scotland was united in a similar manner in the reign of Anne (1707). England, Wales, and Scotland had only one Parliament, and they were included under the common name of Great Britain.

(*c*) After the Irish rebellion of 1798 had been quelled, Ireland sent members to the British Parliament in London, according to the Treaty of Union, Jan. 1, 1801.

Euclid.

1. Let any point D be taken in the base BC of the triangle ABC. Join DA, and at the point D in the straight line DA make the angle ADE equal to the angle EAD. Then AE is equal to ED (Prop. 5, Bk. 1); and if the triangle ABC be folded over along the line ED, the point A will fall on the point D. Another line can be drawn on the other side of AD to answer the requirements of the problem.



2. Prop. 28, Book 1.

3. Prop. 35, Book 1.

The parallelograms are not necessarily equal in all respects.

Algebra.

1.
$$1\tfrac{1}{2}-\tfrac{3}{4}\left\{1-\tfrac{2}{3}\left(x-\tfrac{1}{2}\right)\right\}$$
$$=\tfrac{3}{2}-\tfrac{3}{4}\left(1-\tfrac{2x}{3}+\tfrac{1}{3}\right)$$
$$=\tfrac{3}{2}-\tfrac{3}{4}+\tfrac{x}{2}+\tfrac{1}{4}$$
$$=\tfrac{x}{2}+\tfrac{1}{2},$$
$$\text{and } \left(\tfrac{x}{2}+\tfrac{1}{2}\right)^3=\tfrac{x^3}{8}+\tfrac{3x^2}{8}+\tfrac{3x}{8}+\tfrac{1}{8}. \text{ Ans.}$$
$$\text{Or } \tfrac{1}{8}(x^3+3x^2+3x+1).$$

2.
$$\frac{x^3+x-12}{x^3-5x^2+7x-3}=\frac{(x-3)(x+4)}{(x-3)(x-1)^2}=\frac{x+4}{(x-1)^2(x-1)}.$$

3. (1) L. C. M. of denominators $=10$;
$$\therefore 45-10x=15-7x+18,$$
$$7x-10x=15+18-45,$$
$$3x=12,$$
$$x=4. \text{ Ans.}$$

(2)
$$\frac{13+6x}{15}-\frac{2x}{5}=\frac{3x+15}{5x-25},$$
$$\text{or } \frac{13+6x-6x}{15}=\frac{3x+15}{5x-25},$$
$$\frac{13}{15}=\frac{3x+15}{5x-25}.$$

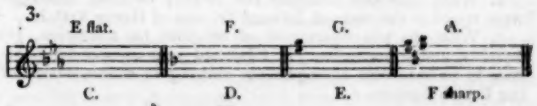
L. C. M. of denominators $=15x-75$;
$$\therefore 13x-65=9x+45,$$
$$13x-9x=45+65,$$
$$4x=110,$$
$$x=27\tfrac{1}{2}. \text{ Ans.}$$

Music.

1.

2.

3.



FOURTH YEAR.

Pupil Teachers at end of Fourth Year, *if apprenticed on, or after,* **1st May 1878; and Pupil Teachers at end of Fifth Year, if apprenticed before that date.**

FIRST PAPER.

Three hours and a half allowed.

Arithmetic.

MALES.

1. What sum of money lent at 4½ per cent. per annum for ·416 of a year will produce £24·4375 interest?

2. A draper sells 104 yards of lace for £138⅔, and thereby loses 10 per cent. At what price per yard should he sell the lace in order to gain 8 per cent.?

3. A bankrupt owes A £256, 6s. 8d., B £203, 10s. 0d., C £141, 13s. 4d.; his estate is worth £421, 1s. 0d.; how much will A, B, C receive respectively?

4. If the 3 per cent. be at 96, how much must a person invest in order that he may derive from it a half-yearly interest of £77, 13s. 4d., after paying 7d. in the £ for income tax?

5. Divide £350 into four shares which shall have the same ratio to one another as the cubes of 1, 2, 3, 4 respectively.

FEMALES.

1. What is the price of 7 packages of cloth, each package containing 7 parcels, each parcel 27 pieces, and each piece 81 yards, at the rate of 1½ guineas for 3 yards?

2. If 252 men can dig a trench 210 yards long, 3 wide, and 2 deep, in 5 days of 11 hours each, in how many days of 11 hours each will 22 men dig a trench of 420 yards long, 5 wide, and 3 deep?

3. Find the simple interest on £98, 15s. 10d. for ½ a year at 2½ per cent.

4. What was the prime cost of an article which, when sold for 12s., realized a profit of 20 per cent.?

Grammar.

1. '*Shall* courtesy *be done* only to the rich, and only by the rich? In good breeding, which differs, *if at all*, from high breeding only as it gracefully remembers the rights of *others* rather than gracefully *insists* on its own rights, I discern no special connection with wealth or birth; but rather *that* it lies in human nature *itself*, and is *due* from all men towards all men.' —CARLYLE, *Sartor Resartus.*

(*a*) Point out any words in the above which seem to you to be of Latin or of French origin, and give, if you can, a particular account of one of them.

(*b*) Parse the words in italics.

(*c*) Analyse from '*In good breeding*' to '*wealth or birth.*'

2. What was the original possessive of *it* (its being a modern form); give examples of its use.

Geography.

1. Give notes of a lesson on 'The great rivers of South America,' under these heads:—

(*a*) Position of sources.
(*b*) General direction.
(*c*) Length and size, as compared with European rivers.
(*d*) Character of country through which they flow.

Illustrate by a map, showing *one* basin.

2. Describe the boundaries, extent, and character of the Indian Ocean.

SECOND PAPER.

One hour allowed for Females, two and a half for Males.

History.

1. 'To Towton Crecy was but sport,
Poitiers but a pageant vain,
And the work of Agincourt
Only like a tournament.'

Give a very brief account, with dates, of the four battles named here.

2. What questions affecting the validity of their marriages were raised in the cases of Edward IV. and of Henry VIII.?

3. What do you understand of religious (*a*) toleration, (*b*) equality, and (*c*) ascendancy? Illustrate your answer by reference to ecclesiastical arrangements existing in different parts of the British Empire.

Penmanship.

Write, in large hand, as a specimen of copy-setting, the word *Burglary.*

Write, in small hand, as a specimen of copy-setting, '*Now, Warwick, tell me, is Edward your true king?*'

Composition.

Write an essay on the Pyramids of Egypt.

Euclid.

[The only abbreviations admitted for 'the square on AB' is 'sq. on AB;' and for 'the rectangle contained by AB and CD,' 'rect. AB, CD.']

1. Why cannot we demonstrate Prop. 4, Book 2, thus:—Let AB=a, and let it be divided into any parts at C; let AC =x, BC=y. Then $a=x+y$; ∴ (squaring) $a^2=x^2+y^2+2xy$; ∴ if a straight line, etc.

2. If a straight line be divided into two equal, and also into two unequal parts, the squares on the two unequal parts are together double of the square on half the line, and of the square on the line between the points of section.

3. In every triangle the square on the side subtending either of the acute angles is less than the squares on the sides containing that angle by twice the rectangle contained by either of these sides, and the straight line intercepted between the acute angle and the perpendicular let fall upon it from the opposite angle.

Algebra.

1. Find the G. C. M. of
$3x^4-x^3y^3-2y^4$ and $10x^4+15x^3y-10x^2y^2-15xy^3$.

2. Simplify $\frac{2}{a-2}-\frac{1}{2+a}-\frac{a+6}{a^2+4}$ and $\frac{(a^2-1)\,(a^6-1)}{(a+1)^2\,(a^2-a)^2}$.

3. Solve the equations—

(1) $\begin{cases} 8x+9y=1250, \\ 13y-17x+279=0. \end{cases}$

(2) $\frac{1}{2}(x-1)\,(x-2)=(x-2\frac{2}{3})\,(x-1\frac{3}{4})$.

Mensuration.

1. Find the rent of a square field whose diagonal is 7 chains 15 links at 45s. per acre.

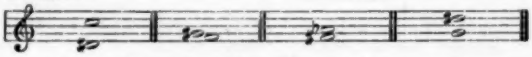
2. How many poles are there in the circumference of a circular plot of ground whose diameter is 42 yards?

Music.

A quarter of an hour allowed for this paper.

1. Write the upper tetrachord of F♯ (*Fe*) minor in every form with which you are acquainted. Mark the places of the semitones and augmented intervals.

2. Write under each of the following pairs of notes the name and quality (major, perfect, diminished, or other) of the interval it forms:—



3. Write the following, at the same pitch, on the treble stave:—

ANSWERS.—FOURTH YEAR.

Arithmetic.

MALES.

1. £4½ would be gained in 1 year by £100;

∴ £24·4375 ,, ·416 yr. by $£100\times\frac{24\cdot4375}{4\cdot5}\times\frac{900}{375}$,

i.e. $£100\times\frac{24\cdot4375}{4\cdot5}\times\frac{12}{5}$,

i.e. £1303, 6s. 8d. Ans.

2. Prime cost of 1 yd. $=£138\frac{2}{3}\times\frac{1}{104}\times\frac{10}{9}$;

∴ price of 1 yd. to gain 8 p. c. $=£138\frac{2}{3}\times\frac{1}{104}\times\frac{10}{9}\times\frac{108}{100}$,

,, ,, ,, $=£\frac{416\times1\times10\times108}{3\times104\times9\times100}$,

,, ,, ,, = £1, 12s. Ans.

3.

	£
A's debt,	256½
B's ,,	203½
C's ,,	141½
Total debts,	£601½

$\therefore$ A gets $\frac{256\frac{1}{2}}{601\frac{1}{2}}$ of £421 $\frac{1}{20} = £\frac{8421}{20} \times \frac{1538}{3609}$
$= £179,\ 8s.\ 8d.$

B gets $\frac{203\frac{1}{2}}{601\frac{1}{2}}$ of £421 $\frac{1}{20} = £\frac{8421}{20} \times \frac{407}{1203}$
$= £142,\ 9s.$

C gets $\frac{141\frac{1}{2}}{601\frac{1}{2}}$ of £421 $\frac{1}{20} = £\frac{8421}{20} \times \frac{850}{3609}$
$= £99,\ 3s.\ 4d.$ Ans.

4. The half-yearly dividend on £96 is 30s.
But after paying 7d. in the £, this half-yearly dividend
$= £\frac{30 \times 233}{4800}$;

$\therefore$ £$\frac{30 \times 233}{4800}$ is the half-yearly interest on £96,

and £77⅔ ,, ,, ,, £96 $\times \frac{233}{3} \times \frac{4800}{30 \times 233}$,
,, ,, ,, ,, £95 $\times \frac{160}{3}$,
,, ,, ,, ,, £5120. Ans.

5.

$1^3 =$	1
$2^3 =$	8
$3^3 =$	27
$4^3 =$	64
	100 shares.

$\therefore$ $\frac{1}{100}$ of £350 = £3, 10s. 1st share,
$\frac{8}{100}$,, = £28, 2d ,,
$\frac{27}{100}$,, = £94, 10s. 3d ,,
$\frac{64}{100}$,, = £224, 4th ,,

FEMALES.

1. $7 \times 7 \times 27 \times 81 = 107163$ yds.;
$\therefore$ cost of 107163 at 1½ guineas for 3 yds. $= £\frac{107163 \times 31\frac{1}{2}}{3 \times 20}$,
,, ,, ,, ,, $= £56,260,11s.6d.$ Ans.

2. Time required $= 5$ days $\times \frac{252 \times 420 \times 5 \times 3}{22 \times 210 \times 3 \times 2}$,
,, $= 5$ days $\times \frac{63 \times 2 \times 5 \times 1}{11 \times 1 \times 1 \times 1}$,
,, $= \frac{3150}{11}$ days.
11 hrs. = 1 day; $\therefore$,, = 286 days 4 hrs. Ans.

3. Interest on £98, 15s. 10d. for ½ yr. at 2½ p.c.
$= £98,15s.10d. \times \frac{1}{2} \times \frac{5}{100}$,
,, ,, ,, ,, $= £98,15s.10d. \div 80$,
,, ,, ,, ,, $= £1,\ 4s.\ 8\frac{3}{4}d.$

4. Prime cost of 120s. worth = 100s.,
,, 1s. ,, $= \frac{100}{120}$s.,
,, 12s. ,, $= 12 \times \frac{100}{120}$,
,, ,, ,, $= 10s.$ Ans.

Grammar.

1. (*a*) *Courtesy* (F.), *rich* (F.), *differs* (L.), *gracefully* (F.), *remembers* (L.), *rights* (L.), *insists* (L.), *discern* (L.), *special* (L.), *connection* (L.), *human* (L.), *nature* (L.), *due* (F.).

Differs is derived from *dis*, asunder, and *ferre*, to carry.

Gracefully is derived from *grâce*, favour, and *fully* (Saxon affix).

Remembers is derived from *re*, again, and *memor*, mindful.

Rights is derived from *rectus*, straight.

Insists is derived from *in*, upon, and *sistere*, to stand.

(*b*) *Shall*—verb, defective, conj. *shall*, *should*, indic. mood, pres. indef. tense, 3d pers. sing. agr. with subj. *courtesy*.
(to) *be done*—trans. verb, strong conj. *do*, *did*, *done*, pass. voice, infin. mood, pres. indef. tense.

if—conditional conj. gov. subordinate clause (*it differ*, etc.).
at all—adverbial phrase, modifying *differ*.
others—indef. pron. 3d pers. plu. num. com. gender, obj. case, gov. by *of*.
insists—intrans. verb (but with *on* trans.), weak conj. indic. mood, pres. indef. tense, 3d pers. sing. agr. with subj. (*it*).
that—conj. introducing noun-clause (*it lies in human*, etc.).
itself—emphatic pron. neut. gen. obj. in apposition with *nature*.
due—adjective, predicative, qualifying *it*.

(*c*)

Sentence.	Subject and Enlargement.	Predicate.	Object and Enlargement.	Extensions.
(*a*) In good breeding I discern no special connection with wealth or birth. (*Principal.*)	I	discern	no special connection with wealth or birth	in good breeding (*place*).
(*b*) Which differs from high breeding only. (*Adjective qual.* 'breeding.')	which	differs from	high breeding	only (*concession*).
(*c*) If (it differ) at all (from high breeding). (*Adverbial of condition.*)	(if) it	(differ from)	(high breeding)	at all (*degree*).
(*d*) As it gracefully remembers the rights of others rather. (*Adverbial of comparison.*)	(as) it	remembers	the rights of others	gracefully (*manner*) rather (*degree*).
(*e*) Than it gracefully insists on its own rights. (*Adverbial comparison.*)	(than) it	insists on	its own rights	gracefully (*manner*).

2. The original possessive of *it* was *his* or *her*; as, 'Learning hath *his* infancy when *it* is but beginning.' 'If the salt have lost *his* savour.' 'The fruit-tree yielding fruit after *his* kind.' 'The tree of life, which yielded *her* fruit every season.'

Geography.

1. THE GREAT RIVERS OF SOUTH AMERICA.

(1) (*a*) The *Amazon*.—Its main feetler, the Marañon, rises in the Andes in Peru, about sixty miles from the Pacific. It issues from a lake in the table-land of Pasco, at an elevation of 14,000 feet. (*b*) The union of the Marañon and Ucayali forms the Amazon, which then flows to the east. (*c*) The mouth of the Amazon is 180 miles wide, and its total length is about 4700 miles. Its basin embraces an area of 2,500,000 square miles. It is more than twice the length of the Volga, and includes four times the area of basin. (*d*) The vast extent of country through which it passes is almost in a state of nature, being mostly covered with immense forests, affording shelter to wild beasts and countless reptiles.

(2) (*a*) The *Rio de la Plata* is formed by the junction of the *Parana* and *Uruguay*. The former rises in the table-land of Brazil, about 120 miles from the Atlantic, and is joined by the *Paraguay*, which rises in Brazil about fourteen degrees south latitude. The Uruguay rises in the east of Brazil, about 75 miles from the Atlantic. (*b*) The river formed by these main streams is merely a broad estuary. The general direction of its branches is south. (*c*) Reckoning from the source of the Paraguay, the total length of the La Plata is 2450 miles, somewhat longer than the Volga; and the basin is estimated at 1,250,000 square miles, twice the size of that of the Volga. (*d*) The two important rivers which go to form the Rio de la Plata from their junction, flow through the extensive grass-covered prairies called the *Pampas*. Above the confluence the Paraguay flows along the most northern part of the plains, which is known as the El Gran Chaco, the southern portion of which is a complete desert for want of rain and water.

2. The Indian Ocean is separated from the Pacific by Australia and the Asiatic Archipelago, and from the Atlantic by Africa.

It extends from the southern coasts of Asia on the north to the Antarctic Circle on the south.

This ocean is estimated to cover 29 millions of square miles.

Properly speaking, it is a double bay of very large size which forces its way up into the land by the two smaller bays of Arabia and Bengal, and still farther by the narrow inlets of the Red Sea and the Persian Gulf. The Indian Ocean is comparatively free from islands, for with the exception of the Malay Archipelago, the islands on the east of Africa are alone worthy of mention; and the largest of these is Madagascar. It contains also several coral reefs. But the most striking feature lies in its periodical winds, called monsoons, which take the place of the trade-winds of the Atlantic and Pacific, are of great value to navigation, and have a great effect on the climate of India.

History.

1. The battle of *Towton*, during the Wars of the Roses, was fought in March 1461, when Edward IV. defeated the Lancastrians, and with great slaughter, as quarter had been forbidden.

At the *Crecy* in France, in 1346, Edward III. totally defeated Philip of Valois. In this battle Edward, Prince of Wales, greatly distinguished himself. Ten years after this (1356), the same Prince of Wales, known as the Black Prince, encountered the army of John the Good at *Poitiers*; and though the English were fewer than the enemy, yet the French were overthrown, and the king was taken prisoner.

At *Agincourt* in Picardy, in 1415, Henry V. defeated an immense French army.

2. Shaw, a preacher, proclaimed in a sermon that as Edward IV. had been under a pre-contract to marry another before he married Elizabeth Woodville, his marriage with the latter was invalid, and thus the claim of Edward V. to the throne should be set aside.

Henry VIII. raised the question of the validity of his marriage with Catherine of Aragon, his brother's widow. This question was raised merely to get a divorce in order to be free to marry Anne Boleyn.

3. By religious *toleration*, which is permitted in every part of the British Empire, is meant the freedom of every religious sect to worship according to its own forms.

By religious *equality* is meant the equal enjoyment of all civil rights and offices. The former are enjoyed by all sects of religion, the latter are not open to all without exception, as, for example, the offices of Prime Minister and of Lord-Lieutenant of Ireland must be held by Protestants.

By religious *ascendancy* is understood the pre-eminence of one sect over others in a country. For example, Presbyterians have the ascendancy in Scotland, Episcopalians in England.

Composition.

THE PYRAMIDS OF EGYPT.

The pyramids of Egypt are buildings resting on a square base, and gradually tapering to a point, each of the four sides or faces bounded by an isosceles triangle. Their total number amounts to about seventy, the most of which are situated along the Libyan ridge from below Cairo to the Fayoum district. The largest are found at Ghizeh, and have attracted the attention of writers of every age; but minute investigations of their structure and the purpose for which they were built date from the time of Bonaparte.

The pyramid was probably built in courses or stages, each receding within the lower and regularly diminishing to the top, thus presenting on each side a series of rude steps, every one of which is smaller than the one on which it rests, the height of these steps likewise diminishing as they ascend. The stones are cut and fitted to each other with great exactness, and cemented with mortar, differing from all modern ones in being composed not of *carbonate* but *sulphate* of lime.

It is sufficient to state that the Great Pyramid covers an area of 13½ acres, and rises to a perpendicular height of 460 feet, but must have been 20 feet higher when entire. Its four faces look towards the four cardinal points of the horizon.

For what purpose they were built has long puzzled the curious. The prevailing opinion has been that they were erected for the one purpose of commemorating certain kings. A few years ago it was pretty satisfactorily established that the Great Pyramid, at least, was built for something connected with science and weights and measures. Professor Smyth, Astronomer-Royal for Scotland, spent some time in the investigation of the truth of the theory, and not only confirmed it, but extended the Great Pyramid standards from line and weight to heat, angle, and time.

Euclid.

1. Since the subject of geometry is *magnitude*, not number, therefore it would be a departure from strict reasoning on space to substitute in geometrical demonstrations the arithmetical or algebraical representation of a rectangle for the rectangle itself.

2. Prop. 9, Book 2.

3. Prop. 13, Book 2.

Algebra.

1. $$\frac{3x^4-x^2y^2-2y^4}{10x^4+15x^3y-10x^2y^2-15xy^3}=\frac{(3x^2+2y^2)(x^2-y^2)}{10x^2(x^2-y^2)+15xy(x^2-y^2)}=\frac{(3x^2+2y^2)(x^2-y^2)}{(10x^2+15xy)(x^2-y^2)};$$

∴ G. C. M. is x^2-y^2. Ans.

2. (a) $$\frac{a}{a-2}-\frac{1}{a+2}-\frac{a+6}{a^2+4}=\frac{2a+4-a+2}{a^2-4}-\frac{a+6}{a^2+4}$$

$$=\frac{a+6}{a^2-4}-\frac{a+6}{a^2+4}$$

$$=\frac{a^3+6a^2+4a+24-(a^3+6a^2-4a-24)}{(a^2-4)(a^2+4)}$$

$$=\frac{8(a+6)}{a^4+16}.$$ Ans.

(b) $$\frac{(a^2-1)(a^2-1)}{(a+1)^2(a^2-a)^2}=\frac{(a-1)(a+1)(a^2+1)(a^2-1)}{(a+1)(a+1)(a-1)(a-1)a^2}$$

$$=\frac{(a-1)(a+1)(a+1)(a^2-a+1)(a-1)(a^2+a+1)}{(a+1)(a+1)(a-1)(a-1)a^2}$$

$$=\frac{(a^2-a+1)(a^2+a+1)}{a^2}$$

$$=\frac{a^4+a^2+1}{a^2}$$

$$=a^2+1+\frac{1}{a^2}.$$ Ans.

3. (1) $8x+9y=1250$, or $136x+153y=21250$

$17x-13y=279$, or $136x-104y=2232$

Subtracting, $257y=19018$

$y=74$. Ans.

∴ $x=73$. Ans.

(2) $$\frac{(x-1)(x-2)}{2}=\left(\frac{3x-8}{3}\right)\left(\frac{4x-7}{4}\right)$$

$$\frac{x^2-3x+2}{2}=\frac{12x^2-53x+56}{12},$$

$6x^2-18x+12=12x^2-53x+56$.

Transposing, $6x^2-12x^2-18x+53x=56-12$.

Collecting and changing signs, $6x^2-35x=-44$.

Dividing by 6, $x^2-\frac{35x}{6}=-\frac{44}{6}$.

Completing square, $\left(x-\frac{35}{12}\right)^2=\frac{1225}{144}-\frac{44}{6}$ or $\frac{1056}{144}$.

$$\left(x-\frac{35}{12}\right)^2=\frac{169}{144}.$$

Taking the root, $x-\frac{35}{12}=\pm\frac{13}{12}$,

$$x=\frac{35}{12}\pm\frac{13}{12},$$

$x=4$ or $1\frac{2}{3}$. Ans.

Mensuration.

1. Area of square $=\frac{\text{square of diagonal}}{2}=\frac{715\times715}{2}$ links

$=\frac{511225}{2}=255612{\cdot}5$ square links $=2{\cdot}556125$ acres at 45s.

45

12780625

10224500

115·025625s.

12

·307500d.

4

1·230000 farthings.

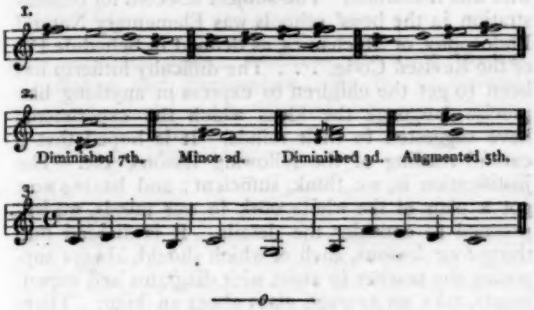
∴ the rent $=$ £5, 15s. 0¼d.

2. Circumference = diameter $\times 3\frac{1}{7}$;

$\therefore$ circumference = 42 yards $\times 3\frac{1}{7} = \frac{42 \times 22}{7}$ yards

$= 132$ yards $= \frac{132}{5\frac{1}{2}}$ poles $= 24$ poles. Ans.

Music.



Engagements for June.

June 2. Linnean Society, ... 8 p.m.
The Royal Archæological Institute, . . 4 p.m.
Church School and S. Benevolent Institution Annual Picnic.
East Kent District Union Annual Meeting.

3. Royal Institution, Professor W. G. Adams, 'Magnetic Disturbance, Auroræ, and Earth Currents,' . . . . . 8 p.m.
Philological Society, Henry Sweet, M.A., Vice-President, 'On Some Points in English Grammar,' . . . . . 8 p.m.
Carlyle Club (Bridge House Hotel), . . 8 p.m.

6. Exam. London University.

7. Society of Biblical Archæology, . . 8 p.m.

8. Geological Society, ... 8 p.m.

10. Royal Institution, Professor Dewar, M.A., F.R.S., M.R.I., 'Origin and Identity of Spectra,' . . . . . 8 p.m.
Royal Astronomical Society, . . . 8 p.m.
New Shakespeare Society, — Poole, Esq., 'On the Alterations in the Acting Editions of Shakespeare's Plays,' . . . 8 p.m.
Cheltenham College Reunion.

13. Geographical Society, ... 8.30 ,,

14. Anthropological Institute, . . . 8 p.m.

16. Linnean Society, ... 8 p.m.

17. Philological Society, Herbert M. Baynes, Esq., 'The Psychological Method in its Application to Language,' . . . . 8 p.m.

18. Stafford District Union.
Inaugural St. Mary's Girls' School, Lichfield. Mr. Rankilor will address the meeting, . . 1.30 ,,

20. Victoria Institute, Rev. H. G. Tomkins, 'Biblical Proper Names, Personal and Local, illustrated from Sources external to Holy Scripture,' . . . . 8 p.m.
Matric. Exam. London University.

22. Geological Society, ... 8 p.m.

24. Battersea College Anniversary.

27. Geographical Society, ... 8.30 ,,

28. Anthropological Institute, . . . 8 p.m.

30. Saltley and York Colleges Vacation commences.

Publications Reviewed.

London Geographical Readers. Book III. for Standard IV. By Charlotte M. Mason. Post 8vo, 316 pp. Price 2s. 3d. London: Edward Stanford.

This is one of the many books called into existence by the now well-known Art. 19, C. 1. In many respects it is unlike any of its rivals, and ought, we feel sure, to take a high rank amongst them. To the scores and scores of friends who from time to time have asked us to recommend a manual which in a brief form presents full and reliable information of the English counties, we say here is the very book. We are mistaken if this entertaining volume has but an ephemeral sale; it deserves a permanent place among standard geographical literature.

The style is highly attractive; indeed, the book reads like a tale. Thirty-six valuable maps enrich its pages.

Payne's Studies in English Literature. Prose and Poetry. Crown 8vo, 960 pp. Price 7s. 6d. London: Crosby Lockwood & Co.

As we turned over the pages of this goodly volume, it was a pleasure to renew old friendships, to shake hands, so to speak, with the men and women who have enriched our mother tongue with their prolific pens.

The selections are admirable, and the whole work one of surpassing merit. So far as we know, there is no kindred work fit to be compared to it. The carefully-written footnotes will prove invaluable to all who use the book.

Self-Culture for All. Part VII. Price 6d. London: Ward, Lock, & Co.

This capital serial has reached its seventh part, which in point of excellence is equal to its predecessors.

Chambers's Geographical Readers. Book II. for Standard III. Fcp. 8vo, 128 pp. Price 10d. London: W. & R. Chambers.

We are much pleased with this cheap unpretending-looking volume designed to meet the requirements of the new article in Geography. Many teachers will thank Mr. Meiklejohn for his little book, whose crowning merit is its *extreme simplicity*. Any child in the Third Standard will read it fluently. We dwell upon this excellence because the language in many of the Geographical Readers already put forth is far too hard. We are, however, sorry to see a host of useless so-called test questions occupying space which could have been turned to better account. The book is embellished with a series of excellent illustrations—illustrations that, we venture to say, will be equally helpful to the teachers as to the scholars. The printing and binding has been done in the Messrs. Chambers's usual commendable style.

Marcus Ward's Arithmetic. By J. W. Marshall. In Three Parts. London: Marcus Ward & Co.

When we opened this book we own to being rather prejudiced in its favour. The tasteful design and imprint on the cover, the excellence of the paper and printing, and the rare clearness of the bold round

type, together with the neat and judicious arrangement of the text, must be our explanation for this prejudice. In these points the book has never been excelled. It is a pleasure to look at it. The writer of the book is no novice: the practised hand of a skilful teacher is shown on every page. A full and simple explanation of each rule is given. The exercises are numerous, well graduated, and include an excellent selection of problems. The higher Standard work is hardly 'stiff' enough—that is, if we keep in view the ever-varying standards set up by H.M. Inspectors. Assuming the answers (which have not been received by us) to be correct, we strongly recommend Marcus Ward's Arithmetic.

The Child's Geography. By M. J. Barrington Ward, M.A. 60 pp. Price 6d. London: Marcus Ward & Co.

As an Inspector of Schools, Mr. Barrington Ward is so conscientious and thoroughly imbued with the love of his work that we are pleased to see his 'Child's Geography.' In an unassuming preface he states that his object in issuing his booklet is to simplify his subject and render it more interesting to the little ones. In this twofold object he has succeeded in a marked degree. The language is at once simple and natural, and quite free from that childishness which too often disfigures books penned expressly for young people.

The excellent illustrations which appear (with one exception) at every opening of the text are appropriate, and lend an additional charm to the work. We regret, however, to find a series of questions tacked on to each page. This is a mistake—a grave one. Good teachers don't need them, and lazy ones should certainly not have them placed at their fingers' ends. It seems to us a pity that this valuable space should be thus wasted. Still the work is a long way ahead of any *introductory* school Geography designed for *young* beginners that it has been our privilege to examine. The cheery little folk who receive their education at home, and who have hitherto spelt their way through the horrid dry question and answer book, will hail its advent with delight. Messrs. Marcus Ward & Co.'s name is a sufficient guarantee that the paper, printing, and binding are all that could be desired for the modest sixpence at which the book is published.

New Testament, Revised Version. 496 pp. cr. 8vo. London: Oxford and Cambridge Warehouses.

We received this volume just as we were going to press. We cannot, therefore, at present, do more than simply announce its publication. The edition with which we have been favoured is well printed in large type (Longprimer) on good paper. The binding is neat and durable.

Class-Book of Elementary Mechanics: An Introduction to Natural Philosophy. Part I., Matter. By William Hewitt, B.Sc. 87 pp. London: George Philip. 1880.

The first and most difficult point to decide with reference to a book on Natural Philosophy, is whether it has the slightest pretence of an excuse for coming into existence at all. When the market is flooded with such, when small men and great men alike have had their say on this subject, it might almost be supposed that it is exhausted. Mr. Hewitt, however, thinks differently. He shall defend himself. 'Some three years ago,' he says, 'the Liverpool School Board resolved to introduce experimental science teaching into their schools, and the writer was appointed to organize a scheme of demonstrations in accordance with this resolution. The subject selected for demonstration in the boys' schools was Elementary Natural Philosophy, or Mechanics, as defined in Schedule IV. of the Revised Code. . . . The difficulty hitherto has been to get the children to express in anything like precise language the ideas which the experiments have suggested to their minds. It is hoped that a careful reading of the following lessons,' etc. The justification is, we think, sufficient; and having now got a plan of the whole work in our minds, we will proceed to consider the details. It is divided into thirty-four lessons, each of which should, always supposing the teacher to assist with diagrams and experiments, take an average class about an hour. There are about half a dozen exercises at the end of each lesson, and a hundred miscellaneous examples at the end.

The exercises are a very praiseworthy part of Mr. Hewitt's work. They must inevitably lead the children to think for themselves. Common incidents, which through their very commonness are deemed insignificant, are here made the vehicle of most important instruction. Take a few examples:—

'When a glass stopper is fast in the neck of a bottle, people sometimes slightly warm the bottle neck, and the stopper comes out easily. Explain this.'

'If the upper portion of the spout of a kettle were cut off, to what height could the kettle be filled with water?'

'People sometimes water plants in flower-pots by letting the pot stand in a saucer of water. Describe and explain the manner in which the water gets to the roots of the plant, and even to the top of the soil.'

'If a dry towel or handkerchief be placed in a basin of water with one end hanging over the side, the water will drop from this end provided it is lower than the surface of the water in the basin. Explain (1) why the material becomes wet at all, and (2) the continual dropping of water from the end outside.'

Simple as these things are, they are yet amply sufficient bases for lectures on expansion, fluid levels, capillarity, and the siphon. The teacher might talk learnedly for hours on the reason of capillarity, and the open-mouthed youngsters, as probably as not, would imagine capillarity was a sort of medicine. But let him take any simple example, bread-crumbs sucking up moisture, flower-pots, or anything, and capillarity would vanish from the Materia Medica to take its place among reasonable phenomena which boys might attempt to understand.

We have said enough on the merits of Mr. Hewitt's work. It is exactly adapted to those for whom it is intended. Yet we have one little bone to pick. Should not absurd inaccuracy in the choice of titles be left to novelists? The ordinary rule of the present day to guide the luckless creature who has written a novel in the choice of a title, is to mix letters in a bag, or after the fashion at Laputa, and take the first set that turns out, respecting it only if it is all consonants. Mr. Hewitt has not quite followed this, but

neither is he altogether original in his method of choice, for it is perfectly certain that three-quarters of the lessons with which we have been dealing have not the remotest possible connection with Mechanics, the science of *Machines*. Indeed, if they had had such a connection, it seems as likely as not that Mr. Hewitt would have called his book Philology or Chemistry.

Mechanics for Junior Students, including Hydrostatics and Pneumatics. By W. J. Browne, M.A. (Lond.), Inspector of National Schools, Ireland. 5th ed. 178 pp. Price 2s. Manchester: John Heywood.

We have next to consider another book on Mechanics, and we are bound to confess at the outset, that Mr. Browne has not succeeded so well in his object as Mr. Hewitt in his. The two books are in a measure complementary, but yet Mr. Browne by no means fills up Mr. Hewitt's deficiencies, and to fill up Mr. Browne's would almost certainly be a task from which Mr. Hewitt would beg to be excused. The one book explains theories by common-sense examples, the other scorns common sense, and proceeds to mathematical demonstrations. We have no great inaccuracies to lay to Mr. Browne's charge; in fact, we have noticed no mistakes, and only one or two misprints not at all important. The chief fault we have to find with the book is its inextricable confusion. Statics, Dynamics, and fragments of Machines are mixed together with lamentable carelessness. From considering Energy and Work, most indisputably dynamical ideas, we are roughly introduced to Friction, which, as far as it is here treated, has a fair right to claim affinity with Statics. But our path is by no means to lie through Statics for the rest of the journey. Scarcely, in fact, have we been introduced to Friction, when we fly off at an abrupt tangent to Impact. And thus, by a wriggling, jerky method, we reach our goal and the welcome end, by no means quite certain that we have not gained a smattering of every science under the sun that has the remotest connection with Mechanics.

There is the same capriciousness in the choice of phenomena that are dignified with an explanation as there is in the arrangement. Capillarity, one of the hardest problems in Hydromechanics, receives half a page and a diagram; while the application of Resolution of Forces to the solution of simple statical problems other than the ordinary run of pulleys, inclined planes, and cranks, is scarcely mentioned.

And then, again, we object to the identification of the Principle of Energy and Virtual Velocities. There is no doubt that Virtual Velocities is *Virtual* Work, but the omission of the adjective makes all the difference. Virtual work and work are not the same, although the one is a particular case of the other, any more than the science of Infinitesimals is a part of Algebra. To apply the Principle of Work, a very ordinary amount of common sense is all that is necessary; but to apply Virtual Work, the Differential Calculus is as often as not quite indispensable—in other words, Work, or Energy, belongs to the domain of Kinematics; Virtual Work, to that of Analytical Statics.

Friction, again, is a theory which, as Mr. Browne presents it, is utterly valueless in practice. It is surely as important to state this as it is to give an empirical formula for the velocity of a shot on leaving a cannon.

But we must have done with our complaints. On the whole, Mr. Browne's book has very many good points. He is peculiarly happy when he gets among Machines, and once there he has the good sense to remain there as long as possible. Five editions have greatly improved the work. We have shown that there is room for further improvement. For the author's sake, let us hope that there is room in the world for another edition.

In conclusion, we will remark that Matriculation Candidates would be greatly benefited by it.

Primer of the Industrial Geography of France. By G. P. Bevan. London: Sonnenschein & Allen.

This so-called primer merits the name of a text-book of the subject on which it treats. The various productions, manufactures, and commercial features of France are not merely enumerated, but described with care and accuracy. Boys and girls will readily follow the agreeable and lucid reasoning which these pages gently associate with the descriptive process. The description, too, is very much more valuable than the bare enumeration of facts to which many geographical books are confined. A capital summary is also given under the heading of a table of **Industries**, in which the product or manufacture is given with the name of the place where carried on. The book is admirably printed, and contains also a succinct and useful table of English equivalents of ordinary French money, weights, and measures. Young readers will find this primer pleasant reading, and finish it with a very different and much superior knowledge of the nature of the leading industrial features of France than from the bare and vague ideas conveyed by many more pretentious books.

The Notation of Vocal Music. By W. W. Pearson. London: Reeves & Novello.

This tract is an attempt to simplify musical notation in the avoidance of key signatures by *Substitution of Pitch*, and thus applies the *principle* of the 'Tonic Sol-Fa system' to the ordinary or established notation. This *principle* indeed is not peculiar to the method or system developed by Mr. Curwen from Miss Glover's idea, as it was in ancient, and we may say general, use till the mistake was made of attempting to establish the Wilhelm or *Fixed Do* system under the Shuttleworth-Hullah effort in 1840. In Lancashire, vocalization was taught under the 'Moveable Do' system; and the same method was developed in a class-book written by the late John Turner, Esq., and published by the Christian Knowledge Society, about the time that Dr. Hullah's adaptation of Wilhelm's method first appeared. Mr. Pearson hits the blot on this 'Moveable Do' nomenclature by the necessity of change of name which this system involves. As 'every note will have seven different names according to the key in which it appears,' the pupil, Mr. Pearson observes, 'will be some time before he makes much progress.'

Without pausing to notice the way in which Balfe Crampton, and the practical drillers of opera singers have cut this knot by the avoidance of the Sol-Fa

syllables altogether, we proceed to mention that Mr. Pearson proposes to render the Natural Key available for music in every key by a plain and simple indication of the (absolute) pitch required, similar in fact to that used by the Sol-Faists. No one can doubt but the path of the learner would be immensely smoothed by this plan, which Mr. Pearson clearly explains. In addition to his explanatory remarks, he also gives a few well-known specimens by way of illustration. Among these is Weldon's *O Praise God*, which also serves to show the simplification of time recommended by Mr. Pearson. This latter proposal involves no serious change, but merely the application of the Crotchet Notation to all kinds of time. To this there can be no more valid objection than to the abandonment of the old *longs* and *breves*. The words used to indicate time movement are sufficiently explicit to justify this attempt to lessen a superfluous nomenclature. In this Mr. Pearson would eliminate $\frac{3}{2}$ and $\frac{3}{8}$ signatures, and for both these use $\frac{3}{4}$ with a suitable term of time movement. With *allegro* or *vivace* $\frac{3}{4}$ meets all the requirements of $\frac{3}{4}$ signature, and with *adagio* or *lento* that of $\frac{3}{4}$, which some regard as essential to ecclesiastical music.

Mr. Pearson recommends the disuse of the Tenor clef with greater diffidence. Yet we are glad to see that he does discountenance this stumbling-block in the path of music which public convenience will no longer tolerate. Part music with the Tenor clef has now very little chance of sale. Even the cautionary 'octave lower' is now generally omitted, and the word TENOR considered quite sufficient to indicate the practical applicability of the Treble clef to Tenor music. Those, however, who admire this fetish sign may have their taste gratified, while the advocates of simplicity may also be satisfied by the placing of the Tenor clef sign across the third space thus: instead of across either the third or the fourth line: a plan now often adopted in this country, and very generally in America. In recommending the use of C key (the natural key) for all vocal music, Mr. Pearson aptly illustrates his object by the use of crooks for the French horn, in which, by a crook for every key, all music is *read* from the key of C. By these remarks Mr. Pearson's aim in the direction of simplicity and utility will doubtless be gathered, in addition to which it is no new nomenclature nor novel notation that he recommends, but merely the application of the established notation to the excision of needless difficulties. 'Let the teacher of elementary singing,' says Mr. Pearson, 'confine his instruction and the practice of his pupils to the key of C, the treble clef, and the crotchet notation, transposing all music otherwise written into these, and I will venture to say that the results will surpass his most sanguine expectations.'

With all this we cordially agree. Nothing can be lost thereby. No step has to be taken that has afterwards to be retraced. Nothing has to be learnt that is afterwards to be unlearnt. Even if the study of keys be hereafter desirable, this preliminary and thorough knowledge of the key of C will facilitate the knowledge of the secondary steps. Doubtless the work of transposition from another to the key of C will greatly aid the knowledge of the use of keys, and a prolonged practice in the key of C also be the best introduction to music in other keys, which, by Mr. Pearson's method, would be needless so far as vocal music is concerned.

The Bicycle Road Book. By Charles Spencer. 219 pp. cr. 8vo. Price 2s. London: Griffith & Farran.

Now that the summer-time is here, and with it the holiday season, tourists are already on the alert planning their 'outings.' To the bicyclist who has not yet made up his mind where to go, we strongly recommend the new edition of Mr. Spencer's valuable road book. In it he will find everything likely to contribute to the enjoyment of his trip. The book is cheap, well bound, printed in clear readable type, and has our best wishes for its success.

Byron's Siege of Corinth, and Wordsworth's Ode to Duty. Price 2d each. London: W. & R. Chambers.

Every teacher must surely know Chambers' reprints of the English classics. Concerning the above two books, the best testimony we can bear is to say they are in all respects fully equal to their worthy predecessors in the same series.

Shakespeare's Midsummer Night's Dream. Edited by Rev. C. E. Moberly. (London: Rivingtons.)

This clearly-printed, carefully-edited handy little volume will prove of great service to those who are reading Shakespeare's *Midsummer Night's Dream*.

Geography for the Use of Schools, designed to assist Candidates preparing for Army, Civil Service, and other Examinations. By W. M. Lupton. London: Longman & Co.

This compendium of geographical facts will be very useful as a book of reference to text-books and other explanatory treatises on Geography, and is intended by its author to be accompanied by his Geographical Questions. Taken alone, it is *not* a book for schools in which the science of Geography is now being wisely associated with reading lessons. Schoolboys, in fact, need the descriptive and instructive features of Geography to be enlarged instead of being diminished; and although we cannot divest our school-books of method and arrangement which are delightfully absent from books of travel and gossiping rambles, yet we believe that geographical facts are better and certainly far more pleasantly acquired by lively and interesting narrative than by a bare enumeration of facts and names. This remark must not be understood as an objection to Mr. Lupton's book, but to its being used injudiciously. As a compendium it evinces remarkable skill in presenting the leading facts and most salient features of every country in every quarter of the globe, and almost of every place of sufficient importance to be thus mentioned. The information is brought down to the present time, to the cession of Dulcigno and Montenegro. The facts mentioned in the enumeration of the principal towns and places of note in Great Britain are particularly well chosen, and present little for objection or correction. The book is also useful in its index of nearly 4000 places, occupying nearly 23 pages. 'Sheerness, at the mouth of the Medway,' might be better stated as being at the *confluence* of the Thames and

Medway. We fear that the former prosperous oyster trade of Poole is nearly destroyed. Some forty years ago, oysters were sold in this old town at the rate of 6d. and 8d. a hundred, but now fetch prices that would drive a Dando to despair. Rochester also was associated with the oyster trade more from being the *entrepôt* of the China Rock and Queenborough fisheries than for having oyster beds of its own. Gravesend we should rather describe as a watering-place and the entrance to the port of London, than on account of its batteries, which, however, are now important. A very useful feature of Mr. Lupton's book in the enumeration of rivers, is the mention of their leading tributaries, together with the principal towns on their respective banks. The glass manufacture of Bristol should have been mentioned in connection with this city, and also that Somersetshire has as good a claim to a large portion of Bristol as Surrey has to a part of London. The mention of many places in connection with recent facts shows that Mr. Lupton is no thoughtless compiler.

Self-Education: An Essay on the Relation between the Teacher and the Taught. Price 1s. London: Guest.

Dr. Hime is an ardent believer in the good old-fashioned way of getting on in life by patient persistent plodding. His essay demonstrates that he who desires to excel may in spite of any difficulties. It denounces the pernicious system of 'cram' which is opposed to all true education, and strongly urges the student to form the habit of relying upon his own powers for success. The book should be widely read.

Johnston's Illustrations of Light and Heat. With Handbook. London: W. & A. K. Johnston.

These beautiful illustrations, accompanied as they are by a useful little handbook, will render the science lecturer great help. And nothing in their way could be better for illustrating an occasional 'object' or 'oral' lesson. The drawing and colouring are so uniformly excellent that the diagrams arrest the attention at once. They are worth buying, if only to brighten up the schoolroom and make it look more attractive.

Wonders of the World. By W. Gilbert. Price 3s. 6d. London: Strahan & Co.

This is a really capital book, one that will delight the old folk as well as the young. Mr. Gilbert has the knack of telling a sensible story in first-rate style, and is never wearisome. We heartily commend his elegantly-bound volume. As a prize, it cannot fail to give satisfaction to the lucky youngster who becomes the happy possessor of it.

Monthly Notes.

[*The Editor will have pleasure in inserting Short Notices of Association meetings. Communications should be written on one side of the paper only, and sent early in the month.*]

THE CONFERENCE ON CODE REFORM was one of the principal educational events of the last month. In consequence of the announcement of the Vice-President, that it had been resolved to introduce considerable changes in the Code, steps were taken to form an association of leading educationists, who should bestow their united consideration on the subject, and submit to the Education Department the result of such consideration. The leading part in the formation of this association was taken by Mr. Mark Wilks, chairman of the School Management Committee of the School Board for London, and the Rev. E. F. M. MacCarthy, chairman of the Education Committee of the Birmingham School Board. The result of their action was, that an association was formed, consisting of the following gentlemen:—

Rev. E. A. Abbot, D.D., Head Master of the City of London School; Rev. Wm. Barnes, Chairman of School Management Committee, Leeds School Board; Rev. J. W. Caldicott, D.D., Head Master of Bristol Grammar School; Charles Doncaster, Esq., Chairman of S. Man. Com., Sheffield School Board; H. W. Eve, Esq., Head Master of University College School, London; Professor G. Carey Foster, F.R.S., Professor of Physics, University College, London; Professor Gladstone, F.R.S., Member of the London School Board; James Hanson, Esq., Chairman of S. Man. Com., Bradford School Board; Professor Henrici, F.R.S., Professor of Applied Mathematics, University College, London; Sir U. Kay-Shuttleworth, Bart., Member of the London School Board; Rev. Brooke Lambert, Vicar of Greenwich; Sir John Lubbock, Bart., F.R.S., M.P. for the University of London; Rev. J. F. McCallan, Chairman of S. Man. Com., Nottingham School Board; Rev. E. F. M. MacCarthy, Chairman of the Education Committee, Birmingham School Board; Professor Meiklejohn, Professor of Education in the University of St. Andrews, N.B.; Richard Morris, Esq., LL.D., President of the Philological Society, London; Rev. T. D. C. Morse, Member of the London School Board; Professor Max Müller, Professor of Comparative Philology, University of Oxford; William Oulton, Esq., Chairman of S. Man. Com., Liverpool School Board; Rev. Mark Pattison, Rector of Lincoln College, Oxford; J. Allanson Picton, Esq., formerly Member of the London School Board; Rev. R. H. Quick, formerly Assistant Master at Harrow School; A. Sonnenschein, Esq., Author of *Science and Art of Arithmetic*, etc.; R. F. Weymouth, Esq., D.Lit., Head Master of Mill Hill School, Middlesex; Mark Whitwill, Esq., Chairman of the Bristol School Board; Mark Wilks, Esq., Chairman of S. Man. Com., London School Board; Rev. Joseph Wood, Chairman of the Leicester School Board; R. Wormell, Esq., D.Sc., Head Master of the Middle Class School, Cowper Street, E.C.

Considerable dissatisfaction was manifested by, and on behalf of, certificated (elementary) teachers that their co-operation was not invited. Non-members were, however, allowed to attend the Conference and to take part in the discussion, though not to vote, and several gentlemen connected with the work of elementary teaching did actually avail themselves of this privilege. The Conference met in the Board Room of the School Board for London, on Thursday the 21st April. Mr. Mark Wilks was elected to preside, and the Rev. Mr. MacCarthy to act as secretary. The chairman opened the proceedings by explaining the origin and objects of the Conference. These objects were, first, to produce a memorial to the Education Department, setting forth generally the principles of the association, and then to apply these principles to the Standards of the Code, thus to examine and determine what were the most practical and practicable Standards of instruction. It was hoped, he said, that sub-committees which had been appointed by the association would have been able to bring up a report to the meeting, including not only a draft of the memorial, but also a rough draft of the proposed alterations in the Standards, and also a revision of the Fourth Schedule. The time at their command had not been sufficient to accomplish the

whole of this purpose. The memorial, however, was prepared. He would therefore suggest that the Conference should devote the present session to the consideration of the memorial, and then adjourn, to meet on the 4th of May for the disposal of the other parts of the programme. This suggestion was unanimously adopted. The draft memorial was then discussed clause by clause, after which the Conference adjourned as agreed upon.

The adjourned Conference on Code Reform was held in the Board Room of the London School Board, on Wednesday the 4th May, Mr. Mark Wilks in the chair. After some discussion, it was moved by Mr. Wilks that the following memorial to the Education Department be adopted. This was adopted with one dissentient :—

To the President, Vice-President, and Lords of the Committee of Council on Education.

We, the undersigned, being intimately associated with Educational Work in this country, and convinced that the whole range of Education from the Elementary School to the Universities is so organically connected that the course of instruction followed in the Elementary Schools cannot but affect directly the work of the Secondary Schools, and through them, to an increasing extent, even the Universities, have long felt that the educational provisions of the existing Code fail to secure either a solid foundation for all Education, or the substantial equipment of the children passing through the public Elementary Schools for their future duties and responsibilities.

We have accordingly heard with the utmost satisfaction that your Lordships have under contemplation the making of fundamental changes in the Regulations of the Code.

We would respectfully submit—that the experience of the past has led to the acceptance of certain general Principles of Education, and that these cannot be neglected without seriously detracting from the value of the early training given at school.

The most important of these principles are—(1) That the Course of Studies should, at each stage, be in harmony with, and adapted to, the natural development of the child's mind and body. (2) That all teaching should proceed from the Known to the Unknown ; from the Particular and the Concrete to the General and the Abstract ; and from the Empirical to the Rational and Scientific.

We would respectfully urge that the Standards (Art. 28) and Stages (Schedule IV.) are, at different points, at variance with one or other of these principles.

We would remind your Lordships that these principles were enunciated by the Committee of Council thirty-seven years ago, and embodied in the Minutes on Methods of Teaching issued by the Committee in 1844 ; and we would also point out that they are recognised in a greater or less degree in the most approved Manuals of Method now in the hands of those who are being trained as Elementary Teachers.

We would therefore ask for the unreserved adoption of these principles as the basis of our Public Elementary Education.

A draft, or series of drafts, were then laid before the Conference, in which were embodied the results of the deliberations of the sub-committees appointed to consider the changes which it is desirable to introduce in the Code with reference to the Standards of Examination and the Fourth Schedule. These received careful and minute consideration from the Conference, and after considerable discussion a large number of suggestions were agreed upon, which it was resolved to present to the Department as in harmony with the general principles embodied in the memorial. The memorial, with the names of the members of the association appended, and these suggestions, have accordingly been presented to the Department. These suggestions have met with considerable approval from the principal educational journals. There is, however, a general agreement that they err in expecting and demanding an amount of work which is beyond the capacity of the children attending Elementary Schools.

BRITISH AND FOREIGN SCHOOL SOCIETY. — The seventy-sixth annual general meeting of the British and Foreign School Society was held on Monday in the Lecture Hall, Borough Road—Lord Aberdare, the President of the Society, in the chair. The report, as read by Mr. A. Bourne, B.A., the secretary, stated that the colleges were quite full, well reported of by the Government, and in a very prosperous condition educationally. Briefly sketching the work of the year, it was shown that at five sets of elementary schools 1957 children were under instruction, with an average attendance of 1501. Of those which were recognised by the Education Department as British and Board schools, there were 4871, with accommodation for 1,468,668, a roll of 1,427,949 names, and an average attendance of 1,012,264. The financial statement showed receipts to the amount of £22,470, 5s. 2d., and an expenditure of £22,445, 11s. 4d., being an excess of receipts of £24, 13s. 10d. With the addition of the money locally received and spent at Darlington, Swansea, and Bangor, the figures became—receipts, £31,063, 11s. 7d. ; expenditure, £30,981, 5s. 1d. ; balance, £82, 6s. 6d.

Lord Aberdare, in moving the adoption of the report and financial statement, said that in all respects the report was a satisfactory one. He also congratulated the Society on the fact that the Board Schools of this country had declared in favour of the system upon which the schools of the British and Foreign Society were instituted. Out of a thousand Boards established since the passing of the Education Act, all but forty-nine had adopted the British School system. A resolution was proposed by Dr. Gladstone, of the London School Board, congratulating the Society on the results of its operations in promoting the Kindergarten system of teaching, and expressing the hope that these operations will be continued and extended.

PRESENTATION DAY AT THE UNIVERSITY OF LONDON was held on Wednesday the 11th ult. Lord Granville, the Chancellor, presided, and the theatre was crowded with ladies and gentlemen interested in the proceedings. A remarkable feature of the proceedings consisted in the fact that this was the first time in the history of the University when degrees were conferred on women. On this occasion three ladies received certificates of matriculation, four received degrees of B.A., and one a prize for French in the First B.A. Examination. Lord Granville, in one of

those charmingly humorous speeches for which he is distinguished, thus referred to this circumstance:—He had to remark that no question had been more warmly discussed than what should be the relation of women to the University. The practice and principle of the latter had widened, and at that moment he was happy to say, so far as education was concerned, ladies could regard that University absolutely on the same footing as men. He felt sure that, however warm the controversy might have been before this decision was taken, now that the experiment was decided on, all feeling of opposition would subside, and those who really had the welfare of the University at heart would be desirous to see the success of that experiment. As far as he knew, there had been no hitch or difficulty in their proceedings, and they had had evidence that day of the way in which the ladies distinguished themselves in the examinations. No less than four ladies, two in the first and two in the second division, had that day become graduates of the University and he believed from certain signs which had been given that day, that the infusion of feminine graduates would add to the utility, as it certainly had done to the grace, of their proceedings. His Lordship also stated that after careful consideration it had been determined to extend the examinations into the science and art of teaching, for which purpose a scheme had been prepared, which would shortly be carried out. This year for the first time the University had conferred degrees for Music, which he considered a satisfactory point. He also announced that their application to the Treasury for the establishment of a practical museum of natural history to enable them to carry on examinations on their own premises had been most liberally met, and he hoped that in a very short time such a department would be opened.

TECHNICAL EDUCATION.—The foundation of the City and Guilds of London Technical College at Cowper Street, Finsbury, was laid by Prince Leopold on Tuesday the 10th ult. The Lord Chancellor and Mr. Mundella attended and took part in the proceedings. Lord Selborne, who, as chairman of the Council of the Institute, was deputed to bid his Royal Highness welcome, having performed this duty, said:—The City and Guilds of London Institute was formed a few years ago by the munificence and liberality of the Livery Companies of London, aided now, he was happy to say, by the Corporation. It was formed with a view of supplying the want to which he had referred, and liberal subscriptions had been given both for annual expenditure and building purposes. The Institute had conducted local examinations, and the readiness of working people to take advantage of them had been signally illustrated. The object of the central institution, for which an available site had been secured at a nominal rent at South Kensington, was to give the highest kinds of instruction necessary to qualify persons to become teachers of the industrial arts. This College was intended especially for the benefit of artisans. The College was not meant to teach trades, or to interfere with the necessary training of the factory and workshop, but it was intended to give them the knowledge which would enable them to receive that training in the most intelligent and effective manner; and that such an institution was appreciated by artisans had been abundantly proved. The work was already in progress. By the aid of the proprietors of the middle class schools, they had been for two or three years past carrying on in suitable class-rooms the instruction of artisans in Applied Chemistry and Applied Physics, and the appreciation and success of that instruction had been great. Another branch had been opened at Castle Street, Leicester Square, for handicrafts; but when that College was finished, the work would be transferred there. The building would contain thirty-two rooms, including a large laboratory, two lecture theatres, suitable class-rooms, workshops, engine-room; and there would be ample accommodation for the full development of the work which had to be done.

A DOMESTIC ECONOMY CONGRESS was held on the 20th May, which was attended by a large number of ladies of rank, and others. We were obliged to go to press, however, before receiving an account of the proceedings.

FREE EDUCATION (SCOTLAND) BILL.—On Wednesday the 18th May, Dr. Cameron, one of the members for Glasgow, moved the second reading of this bill. The object of the bill was to bestow absolute discretion on School Boards, if they thought proper, to give free education to the children in their districts. Colonel Barne moved the rejection of the bill. It was opposed by some members on the ground that it was in advance of public opinion, and by others because they disapproved of its principle. Mr. Mundella affirmed that the present law was working admirably, and that the adoption of this measure would rather retard than advance popular education in Scotland. The measure was eventually withdrawn.

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Query Column.

*** *Communications for this column must reach the Office not later than the 15th inst., and should be addressed,* 'THE QUERY EDITOR' of the *Practical Teacher*, Pilgrim St., Ludgate Hill, London, E.C.

We are now receiving such a number of Queries that we are obliged for the future to limit each Correspondent to one question. When more than one is sent, we shall if possible give hints for the solution of all, or solve the most difficult only. All, however, who attend to our rule may be sure of getting their question fully explained.

1. JOHN PEGG, Leicester.—The month of July 1828 was remarkable for excessive rains. At Derby the quantity collected in the pluviometer between the hours of *nine* A.M. of the 9th of that month and *six* the following morning (an interval of 21 hours) was 3·59 inches; to the evening of the 15th it amounted to 7¼ inches; and by the conclusion of the 29th (an interval of 21 days, of which 10 only were very rainy) the total depth of water collected was 11¼ inches. How many hogsheads of 54 and 63 imperial gallons respectively fall on an acre of ground to amount to the depth of one inch? and how many hogsheads of each kind fell on the surface of an acre during each of the three several periods above mentioned?

We will work the sum with the hogshead of 54 gallons so as to exhibit the method.

An acre=6,272,640 sq. inches;

∴ this same number of cubic inches cover an acre to the depth of 1 inch. But a gallon=277·274 cubic inches; ∴ in the case before us $\frac{6272640}{(277{\cdot}274) \times 54}$ hogsheads fell on an acre.

This can be easily evaluated. It is about 429.

To take now the first of the specified periods, 3·59 inches were recorded by the rain-gauge, say 3·6. This gives 3·6 × 429, *i.e.* about 1544 hogsheads, etc.

All the other parts are similar, but increasingly tedious.

J. P. will always find the following figures useful in such questions :—

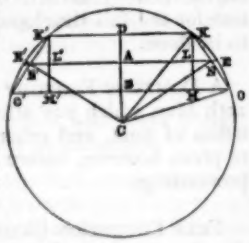
An imperial gallon contains 277·274 (277⅓) cubic inches.

A cubic foot of water weighs 997 (1000 nearly) oz. avoir.

'A pint of pure water
Weighs a pound and a quarter.'

A more exact statement can be easily obtained.

2. WILLIAM SEYMOUR, South Shields.—A hole of 1½ inch radius is cut through a sphere 14 inches in diameter, the axis of the hole being 3½ inches from the axis of the sphere; required the volume of the waste, and the area of the spherical surface removed.



Let us take a central section of the sphere containing the axis of the cylindrical hole.

We judge it more instructive to work this problem with algebraical values, so as to obtain a general result. Let LAL' be axis of cylinder.

Let $CA=d$, $BA=AD=a$,

$CK=CO=\text{radius}=r$.

KM, K'M', CD are perpendiculars, as also is CNE, since KN = NO, $CD=d+a$, $CB=d-a$.

$DK=\sqrt{CK^2-CD^2}=\sqrt{r^2-(d+a)^2}$, so $BO=\sqrt{r^2-(d-a)^2}$.

$MO=\sqrt{r^2-(d-a)^2}-\sqrt{r^2-(d+a)^2}$;

∴ volume of frustum of cylinder KMO = (area of base KM) $\times LN=\pi a^2 \cdot \frac{MO}{2}$

$$=\frac{\pi a^2}{2}\left\{\sqrt{r^2-(d-a)^2}-\sqrt{r^2-(d+a)^2}\right\}.$$

Call this expression x.

Also volume of cylinder $KMM'K'=\pi a^2 \cdot KK'$

Call this y. $\quad=2\pi a^2\sqrt{r^2-(d+a)^2}$.

Now the hole, of which O'K'KO is the plane section, is made up of (α) cylinder KMM'K, (β) two equal frusta KMO, K'M'O', (γ) two equal spherical segments KEO, K'E'O'. We must therefore proceed to find volume of KEO.

$$KO^2=KM^2+MO^2=4a^2+r^2-(d-a)^2+r^2-(d+a)^2$$
$$-2\sqrt{\{r^2-(d-a)^2\}\{r^2-(d+a)^2\}};$$

$$\therefore KN=\frac{KO}{2}=(\text{easily})$$

$$\sqrt{\tfrac{1}{4}\{a^2+r^2-d^2-\sqrt{r^4+a^4+a^4-2r^2d^2-2a^2d^2-2a^2r^2}\}}.$$

Call this expression p.

$CN=\sqrt{r^2-p^2}$, $NE=r-\sqrt{r^2-p^2}$. Call this q;

∴ volume $=\frac{\pi \cdot NE}{6}\{3KN^2+NE^2\}$ (by ordinary formula)

$$=\frac{\pi q}{6}\{3p^2+q^2\}. \quad \text{Call this } z.$$

Hence total volume of waste $=y+2x+2z$.

In the given example $a=1\frac{1}{2}$, $r=7$, $d=3\frac{1}{2}$.

For the evaluation of p it should be noted that $r^4+d^4+a^4-2r^2d^2-2a^2d^2-2a^2r^2$ readily splits into factors.

It will be very instructive to imagine the extreme case in which the axis of the cylinder passes through the centre of the sphere, and its radius is equal to r. The whole sphere is evidently included, and we ought to get as our result $\frac{4}{3}\pi r^3$.

We have $d=0$, $a=r$. Hence $x=0=y$.

$$\text{Also } p=\sqrt{\tfrac{1}{2}\{r^2+r^2-\sqrt{2r^4-2r^4}\}}=r$$

$q=r$,

$$z=\frac{\pi r}{6}\{3r^2+r^2\}=\tfrac{2}{3}\pi r^3;$$

∴ whole volume $=y+2x+2z=\frac{4}{3}\pi r^3$.

3. A goods train starts from A to B at 12 o'clock, and a passenger train at 1 o'clock. After travelling ⅔ of the entire distance, the former then goes at ½ of its first rate, and is thereby overtaken by the latter at 20 minutes past 2, their distance from B being then 10 miles. The rate of the passenger train is twice the diminished rate of the other. Find the distance from A to B, and also the speed of each train.

Let x miles an hour be original rate of goods train.

y be distance from A to B.

$\frac{5x}{3}$ is rate of passenger train.

Distance from A when overtaken is $y-10$ miles.

Passenger train has done this in 1 hr. 20 min.;

$$\therefore y-10=\frac{4}{3}\cdot\frac{5x}{3}=\frac{20x}{9}. \quad . \quad . \quad (1)$$

Also for $\frac{3y}{4}$ miles goods train has travelled at x miles.

$\frac{y}{4}-10$ " " $\frac{5x}{6}$ "

$$\therefore 2\tfrac{1}{2}=\frac{3y}{4x}+\frac{\frac{y}{4}-10}{\frac{5x}{6}}. \quad . \quad . \quad . \quad (2)$$

These two {(1) and (2)} readily give $20x=9y-90$.

$20x=9y-102\frac{1}{2}$.

But these equations are inconsistent, and therefore the problem under its present conditions is impossible.

4. From a certain station the angle of elevation of a tower is observed; 20 feet nearer to the base a new observation is taken, and the angle is the complement of the former; 6 feet nearer still, all in the same right line, another angle is taken, and found to be double of the first angle. Required the height of the tower.

Construct the following figure :—

Let AE be the tower; B, C, D, the successive points of observation. $ABC=\theta$, $ACD=90-\theta$, $ADE=2\theta$.

Let $AE=x$ = height of tower, $DE=y$.

Then at once $\frac{x}{y+26}=\tan\theta$ (1). $\quad\frac{x}{y+6}=\cot\theta$ (2).

$$\frac{x}{y}=\tan 2\theta \text{ (3)}.$$

From (1) and (2) $\frac{y+26}{x}-\frac{y+6}{x}=\cot\theta-\tan\theta=\frac{2\cos 2\theta}{\sin 2\theta}$

$=\frac{2y}{x}$, by (3);

$$\therefore \frac{20}{x}=\frac{2y}{x}; \quad \therefore y=10.$$

Also multiplying (1) and (2), $x^2=(y+6)(y+26)$
$=(10+6)(10+26)$;

$\therefore x=4\times 6=24$ feet.

5. IVANHOE, Dronfield.—Inscribe a rhombus within a given parallelogram, so that one of the angular points of the rhombus may be at a given point on the side of the parallelogram (Tod-hunter's *Euclid*, Ex. 93).

Let ABCD be the parallelogram and E the point in the side AD. Then the student will easily be able to construct the figure, thus :—In CB take CF equal to AE. Join AC and EF meeting in G. Draw KGL perpendicular to EF. Then there will be two cases :—

(1) When KGL meets BC and AD before meeting AB and CD. Suppose this to happen. Let KGL meet BC in K and AD in L, K and L being between B and C and A and D respectively. Join EK, FL. Then EKFL is the rhombus; for the triangles AEG and FGC have all their angles equal (see Euclid I. 15 and I. 29). Hence AG is equal to GC, and EG to GF. But the diagonal BD must pass through the middle point of AC. Hence BGD is a straight line, and BG=GD, since the diagonals of a parallelogram bisect each other. Also by I. 15 and I. 29 again, BGK and LGD are similar, and BG=GD. Hence we must have KG=GL. We can now easily prove that EKFL is a rhombus. EG=GF, LG is common to the two triangles EGL, FGL, and EGL=right angle=FGL. Hence (Euclid I. 4) EL=LF. In a similar way we get LF=FK, and FK=EK. Hence EL = LF = FK = EK, or EKFL is a rhombus.

(2) When KGL meets AB and DC before meeting BC and AD, it will be found that although the rhombus is now inscribed in a slightly different sense, precisely the same wording applies for the proof.

There is still a third case.

(3) When KGL meets BC and AD first; but instead of con-

structing the rhombus as EKFL, we *produce* KGL to meet AB, CD in M and N respectively. Then it will be found that EMFN is a rhombus.

(4) Of course there is a similar extension when KGL meets AB and CD first.

In these latter cases, although part of the rhombus is *outside* the parallelogram, yet every angular point lies on the sides of the parallelogram, and hence, according to the ordinary definitions, it is *inscribed*, more properly *escribed*. We have still one other method of *escribing* a rhombus.

With this extended meaning of the definition, it is quite possible that other solutions may be found; in fact, there will certainly be one such solution when the diagonal EP of the rhombus lies in AD. It is easily found thus:—

Take Q, the middle point of AD, and find P such that EQ=QP; then draw RQS perpendicular to EP, meeting AB and CD respectively produced in R and S. Then it can be proved at once that ERPS is a rhombus.

6. If a triangle is described having two of its sides equal to the diagonals of any quadrilateral, and the included angle equal to either of the angles between these diagonals, then the area of the triangle is equal to the area of the quadrilateral (Todhunter's *Euclid*, Ex. 105).

Let ABCD be the quadrilateral, with diagonals intersecting in E. By trigonometry the result at once follows:—Area quad. $= \frac{1}{2}(AE.BE + BE.EC + EC.ED + ED.EA)$ sin BEC $= \frac{1}{2}(AE + EC)(BE + ED)$ sin BEC $= \frac{1}{2}AC.BD$ sin BEC.

To adapt this to geometry, draw AH, CJ perpendicular to BD, and suppose the angle AEB acute. Let the triangle LMN have the angle LMN equal to AEB, LM equal to BD, and MN to AC. Draw NP perpendicular to ML. Then area of quadrilateral = sum of areas of triangles ADB, CDB $= \frac{1}{2}AH.BD + \frac{1}{2}CJ.BD = \frac{1}{2}(AH + CJ)BD$. But AEH=JEC=PMN, and EJC=right angle=EHA=MPN. Hence AEH, ECJ, MPN are similar. Hence (VI. 4),

$$\begin{aligned} &AE : AH :: CE : CJ :: MN : PN \\ &:: AE + CE : AH + CJ :: MN : PN \\ &:: AC : AH + CJ :: MN : PN \\ &:: MN : AH + CJ :: MN : PN; \\ &\therefore AH + CJ = PN; \end{aligned}$$

$\therefore$ area quadrilateral $= \frac{1}{2}PN.BD = \frac{1}{2}.PN.ML =$ area triangle.

In a similar way, the theorem can be proved when AEB is obtuse, the only difference being that P does not then fall between M and L. These obviously include all cases.

7. 'SUMMUM BONUM,' Oban, wishes information as to how to make a 'commonplace' book, also would like to know what Locke's plan is. We believe that this latter scarcely differs at all from the ordinary one for an *Index Rerum*. Our correspondent must surely have seen little pocket-books with 'Where is it?' on the back. An *Index Rerum* is simply an enlarged edition of this. It can be easily made as follows. Take an ordinary exercise-book, value about 1s., and snip off a narrow column from the outer edge of the first ten pages, say, leaving only a square piece at the top, on which write A, thus:—

For the next letter snip off a similar narrow column, leaving a piece at the top twice as deep as before, and write B on the *lower* part of this, so that, when the book is shut, *both* the A and B will be distinctly visible. Continue this process throughout the alphabet. Thus, since each letter is visible without opening the book, you can turn at once to any particular one, and are saved the trouble of an interminable index. We would recommend our correspondent, if he deems it advisable to keep any such thing at all, to keep two—one strictly an *Index Rerum*, the other a quotation-book. The use of the first is almost obvious. Whenever, in reading a standard book in your possession, you come across a passage that strikes you as able to bear a second reading, and these will be few enough, make a note of its position, cataloguing it under the most prominent word or thought, and adding a few descriptive hints to remind you of what it is treating, so that you can see at once whether you have got hold of the right one when you look it up again. The following is a specimen entry, for instance, all easily compressible into one line of small manuscript:—

'Life, allegorical picture of, Carlyle, *Sartor Resartus*, Bk. iii. chap. viii. p. 184, People's Edn.'

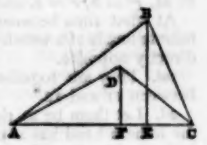
It is hopeless to attempt to arrange the heads in strict alphabetical order. You must be content with having all of one initial letter together, and add others just as they come, without reference to their proper sequence. In shorthand, too, several notes might with advantage be added, such as, 'Suitable for peroration,' of a speech. Probably one word, 'peroration,' would be a sufficient reminder in this case.

The quotation-book should *never* be used for standard books, books in your own possession, or books that you can easily obtain, otherwise it will be full far sooner than you wish it. Any passage in a book which you meet once, and are not likely to meet again, or any jotting from an ephemeral magazine that pleases you, should be transferred bodily, and then its position in the quotation-book registered in the *Index Rerum*.

In conclusion, we would advise our correspondent not to attempt the formation of such books until his literary tastes are fully formed, otherwise it may happen that a year after the book is made it will annoy him by its very stupidity, for he will have lost the taste for some passage which then quite took his fancy, but now seems wonderfully weak.

8. R. GIBBONS, Stockport.—One diagonal of a quadrilateral, which lies outside the figure, is 70 feet, and the difference of the perpendiculars upon it from the extremities of the other diagonal is 16 feet. Find the area.

Let ABCD be the quadrilateral, AC the diagonal outside the figure. Then we are given AC=70, BE−DF=16, where BE and DF are perpendiculars on AC.



Now quadrilateral ABCD=triangle ABC−triangle ADC

$= \frac{1}{2}AC.BE - \frac{1}{2}AC.DF$

$= \frac{1}{2}AC(BE - DF)$

$= \frac{1}{2}.70.16 = 560$ sq. feet.

9. W. H. W., Westfield.—Given one side of a right-angled triangle, and the sum or difference between the hypotenuse and the other side to construct the triangle.

We will first suppose the difference given.

Let AB be the given side. At B erect BD perpendicular to AB, and make BD equal to the given difference. Join AD, and at A make the angle DAC equal to the angle ADB, and produce AC and DB to meet in C. Then ABC is triangle required, for AC − CB = CD − CB = BD = given difference, and ABC is a right angle.

Secondly, if the sum is given.

The construction will be found precisely the same, the figure differing in that C now lies between B and D.

Or a method of solution might be derived at once by algebra. Let d=given difference, x and y the unknown sides, b the given base. Then $x^2 - y^2 = b^2$, $x - y = d$, $x + y = \frac{b^2}{d}$. Hence on the given difference or sum construct a rectangle equal in area to the square on the given base; its other side will be the sum (or difference) of x and y. The rest is obvious; $x - y = d$, $x + y = \frac{b^2}{d}$, $x = \frac{d + \frac{b^2}{d}}{2} = \frac{d^2 + b^2}{2d}$, the form of which suggests another direct construction for x. Find a rectangle one of whose sides is $2d$, and whose area is equal to that of the square on AD in the former part of the question; its other side is x.

10. R. J. WHITE, Woolwich, wishes to know if there is any annotated editions of Wordsworth's 'Ode to Duty,' 'Ode to Immortality,' and 'Poems dedicated to National Independence and Liberty.'

We do not believe that any such is yet published; we have certainly not met with them, nor is any one mentioned in the last number of the *Bookseller's Catalogue*. Messrs. Rivington publish an annotated edition of several miscellaneous poems of Wordsworth; but as we have not yet had an opportunity of examining this, we cannot say whether any of those you mention is among them. The price is 1s. If not successful there, try Chambers. See 'Reviews' in this number.

11. AN IMPERFECT GRAMMARIAN wishes an explanation of the phrases:—'*it weighed six pounds*;' '*it was three ells long*;' '*methinks*;' '*it is worth sixpence*;' '*the more the merrier*;' '*a dog yclept Pompey*;' '*if you please*.'

We do not wonder that Lindley Murray failed to satisfy you. Try Mason's *English Grammar*, to the value of which more than twenty editions are sufficient testimony. Publisher, G. Bell, price 3s. 6d. It will solve all your difficulties. Bain's *Com-*

panion to the Higher English Grammar you would find a very useful book in teaching that subject. It makes an especial point of discussing such phrases. Publisher, Longmans, price 3s. 6d.

12. R. C. BEAN wishes a complete list of guide-books, books, and periodicals bearing on the London 1st B.A.

This is a scarcely reasonable request. We can only say that Mr. Sparkes has produced a guide to the 1st B.A. which possibly may do you some little good. Ask your bookseller for it. To get an idea of what your request would mean, refer to the last two or three pages of his work, and you will find a list complete enough to please any one, on the assumption that completeness and bulk are identical. We have not the slightest objection to give you advice to aid your choice of books on special subjects, say Classics or Mathematics, or to help you in any other dilemma, but we really could not admit such a wholesale tax on our space, especially in a case in which many booksellers could relieve you at once.

13. H. W. CROWE, Otley.—Find two mean proportionals between 3 and 24.

If they be $3r$, $3r^2$; 3, $3r$, $3r^2$, and 24 must be a G.P.; $\therefore 3r^3 = 24$, $r^3 = 8$, $r = 2$, and hence the proportionals are 6 and 12.

At what time between 11 and 12 o'clock are the hour and minute hands of a watch—1st, together; 2d, at right angles; 3d, directly opposite.

1st. They are together at 12 o'clock, and at no other time between 11 and 12.

2d. Let them be at right angles x minutes before 12. Then the minute hand has x minute space to traverse, and (construct a figure) the hour hand $\{x + 15\ (= \text{right angle}) - 60\}$ minute spaces before reaching 12 o'clock. But the minute hand goes at 12 times rate of hour hand;

$$\therefore \frac{x}{12} = x - 45; \ \therefore \frac{11x}{12} = 45,$$

$$x = \frac{540}{11} = 49\tfrac{1}{11}.$$

Hence the event happens at $10\frac{10}{11}$ minutes past 11.

3d, opposite. In a similar way the minute hand has y minute spaces, hour hand has $\{y + 30\ (= 2 \text{ right angles}) - 60\}$.

Hence $\frac{y}{12} = y - 30$, $y = \frac{360}{11} = 32\frac{8}{11}$.

Hence the hands are opposite at $27\frac{3}{11}$ minutes past 11.

14. J. W. PEGG, Barlestone.—A person wishing to know the height of a wall, the foot of which was inaccessible, fixed an upright staff five feet high (the height of his eye) at the place where the angular altitude above the level of his eye was 45°. Having then walked backwards till the angle between the top of the wall and the top of the staff was 18° 26′, of which the tangent is $\frac{1}{3}$, he found by actual measurement that his distance from the staff was 70 feet.

Determine the height of the wall.

Let EG be wall, CD the staff, AB the man in second position, BDG the ground (horizontal), ACF likewise horizontal and parallel to BDG. Join AE, CE.

Then EAF = 18° 26′, ECF = 45.

Let EG = x, EF = $x - 5$ = CF $\{\because$ CEF = ECF$\}$.

AC = 70; $\therefore$ AF = $70 + x - 5 = 65 + x$.

$$\frac{EF}{AF} = \tan EAF = \tan 18° 26' = \tfrac{1}{3};$$

$$\therefore \frac{x-5}{x+65} = \tfrac{1}{3},\ 3x - 15 = x + 65,\ 2x = 80,\ x = 40;$$

$\therefore$ the tower is forty feet high.

15. FRERE, Barrow-in-Furness, wishes to know how she may obtain a certificate 'for an extra subject such as French, so as to be eligible for a situation where it is required.'

We think your best plan would be to take the Cambridge Higher Local Examinations for Women. Certificates are there given for proficiency in special subjects, which would be of considerably more value than that of a visiting inspector, as you suggest. The secretary, Rev. G. F. Browne, St. Catharine's College, Cambridge, will send you a copy of the Regulations, etc., post free, on application.

16. J. D. M., Weston-super-Mare.—A grocer buys 2 cwt. of tea. The first cwt. he sells at 5 per cent. profit, and the second cwt., which costs £1 more, at 12 per cent. profit, the difference of the retail price being 4d. per lb. Find the cost price per lb. of each kind.

Suppose wholesale price of first kind £x per cwt.

Then wholesale price of second kind is £$(x+1)$ per cwt.

Hence selling price of first kind £$\frac{21x}{20}$ per cwt., since there is a profit of 5 per cent.

And selling price of second kind is £$\frac{28}{25}(x+1)$ per cwt., since there is a profit of 12 per cent.

But the retail prices differ by 4d. per lb., *i.e.* £$\frac{28}{15}$ per cwt.;

$$\therefore \frac{28}{25}(x+1) - \frac{21x}{20} = \frac{28}{15}.$$

Multiply by 300:—$336(x+1) - 315x = 560$,

$$21x = 224,\ x = £10\tfrac{2}{3} \text{ per cwt.}$$

$$= \frac{\overset{2}{\cancel{32}} \times 20}{3 \times \underset{7}{\cancel{112}}}\text{s. per lb.} = \frac{40}{21}\text{s.} = 1\text{s. } 11\text{d. nearly.}$$

Price of second kind is £$(x+1)$ per cwt. = £$11\frac{2}{3}$ per cwt.

$$= \frac{\overset{5}{\cancel{35}} \times \overset{5}{\cancel{20}}}{3 \times \underset{16\ 4}{\cancel{112}}} = \frac{25}{12}\text{s. per lb.} = 2\text{s. } 1\text{d. exactly.}$$

17. An up-train, 88 yards long, travelling at the rate of 35 miles an hour, meets a down-train, 88 yards long, at 12 o'clock, and passes it in 6 seconds. At 15 minutes and 3 seconds past 12 the up-train meets a second down-train, 132 yards long, and passes it also in 6 seconds. At what time will the second down-train run into the first?

In such sums we find the time in which one train will pass another, as follows:—Suppose one train at rest and the other to move with a velocity equal to the sum of the two velocities of the trains. Then the moving train will first reach the engine of the other train, then the other end, then its whole length will have to pass this other end. Hence the rule: Divide sum of lengths of trains expressed in miles by sum of velocities of trains. The result will be the time occupied in passing.

Thus the total velocity of the two trains here is such that 176 yards are traversed in 6 seconds, *i.e.* 88 feet per second, *i.e.* 60 miles per hour. But one train moves at 35 miles; hence the other moves at 25 miles.

Similarly in the second case 220 yards are traversed in 6 seconds; $\therefore$ the total rate is $82\frac{1}{2}$ miles per hour; $\therefore$ the rate of the second train is $47\frac{1}{2}$ miles per hour.

Also the first down-train and the up-train are separating at 60 miles per hour; hence in $15\frac{1}{20}$ minutes they will be $\frac{301}{20}$ miles apart.

Now the two down-trains are decreasing the distance between them at $47\frac{1}{2} - 25 = 22\frac{1}{2}$ miles per hour; $\therefore$ they will cover $\frac{301}{20}$ miles in $\frac{301 \times \overset{2}{\cancel{2}}}{\underset{10}{\cancel{20}} \times 45} = \frac{301}{450}$ hour, *i.e.* 40 minutes 8 seconds.

Hence the trains run into one another at 55 minutes and 11 seconds past 12.

18. If 8 men and 6 boys reap 15 acres in 2 days, and 5 men and 8 boys can reap 23 acres in 4 days, how many boys will be required along with 3 men to reap 17 acres in 4 days?

Suppose a man to be as efficient as x boys.

8 men and 6 boys = $8x + 6$ boys reap 15 ac. in 2 days,

1 boy reaps 1 ac. in $\frac{2(8x+6)}{15}$ days,

$5x + 8$ boys reap 23 ac. in 4 days,

1 boy reaps 1 ac. in $\frac{4(5x+8)}{23}$ days.

Hence $\frac{2(8x+6)}{15} = \frac{4(5x+8)}{23}$, $51 = 17x$, $x = 3$.

Hence 1 boy reaps 1 ac. in 4 days, 17 boys reap 17 ac. in 4 days.

17 boys = 9 boys + 8 boys = 3 men + 8 boys.

19. W. S., Wirksworth.—Which English battle from 1300 to 1400 is considered by Froissart to have been the best fought? What other historians agree with him?

Cressy, we believe, but can scarcely pretend to be answerable for or even fully conversant with Froissart's opinions; nor is it quite fair to expect us to know whether any of the numerous gentlemen fated to write history agreed with him. Some do, we believe.

20. C. W. EASTON, Gressenhall.—Pitman's System of Shorthand, which he calls Phonography, is very much the best. Its general use is attested to by the fact that of the sixteen reporters on the staff of the *Times*, eight are phonographers. The acquirement is not a matter of a moment. Practise honestly an hour a day for a year, and we can assure you of 100 words per minute. Three years' practice will bring you to 180, and this is the limit. Purchase from F. Pitman, Paternoster Row, *The Phonographic Teacher* (price 6d.), and *Exercises in Phonography* (1d.). After that, the *Manual* and *Reporter*. But we refer you to Pitman's books for further instruction.

Order the Syllabus for the Elementary Teachers' Certificate Examination from any bookseller.

As to studying Virgil's *Æneid*, Books I.-III., *do not get a translation*. We have previously, in these columns, recommended Bryce's edition, which is fully enough annotated. You may, but we hope you never will, find a literal prose translation in Bohn's 'Classical Library.' Conington's verse translation is the best, but there are no notes.

21. BRISTOLIAN, Bristol, DELMER, and others.—Is there any rule to arrange the digits 58, 967, 537, so that the number formed may be divisible by 19?

These digits naturally split up into four sets of two, 57, 95, 76, 38. Each pair is divisible by 19, and thus the numbers formed by arranging these pairs of digits in any order would satisfy the condition. There are evidently twenty-four such numbers. It seems to us that there can be no general rule for such sums; for, to take one instance only, the number formed by *nineteen nines* is divisible by 19, no matter in what way we arrange these nines. Now if it were possible to find a general rule to include all cases, we have a fair right to apply it to this particular one, and we obtain several arrangements of these nines as being the *only* ones which will give a resultant number satisfying the condition. This is absurd.

22. W. R., Shetland.—A railway train, after travelling for one hour, meets with an accident which delays it one hour; after which it proceeds at three-fifths of its former rate, and arrives at the terminus three hours behind time. Had the accident occurred 50 miles farther on, the train would have arrived 1 hour 20 minutes sooner. Required the length of the line, and the original rate of the train (Todhunter's *Algebra*, p. 103, Ex. 25).

Let x=original rate of train, y=distance between places.

In 1 hour train goes x miles; $\therefore$ there are $y-x$ miles to do after the accident, at $\frac{3x}{5}$ miles per hour; $\therefore$ it takes $\frac{5(y-x)}{3x}$ hours.

Hence in the journey altogether it takes $\frac{5(y-x)}{3x}+2$ hours, since it is delayed 1 hour. But it should have taken $\frac{y}{x}$ hours;

$$\therefore \frac{5(y-x)}{3x}+2=\frac{y}{x}+3;$$

$$\therefore 5(y-x)=3(y+x),\ 2y=8x,\ y=4x.$$

In the second case there are $y-50-x$ miles to be done at reduced speed; $\therefore$ it takes $\frac{5(y-50-x)}{3x}$ hours. Also it would do 50 miles in $\frac{50}{x}$ hours; $\therefore$ before the accident it had been travelling $1+\frac{50}{x}$ hours;

$$\therefore \text{it was } \frac{5(y-50-x)}{3x}+\frac{x+50}{x}+1 \text{ hours on the route}$$

$$=(\text{as before})\ \frac{y}{x}+\left(3-1\frac{1}{3}\right)$$

$$=\frac{y}{x}+\frac{5}{3};$$

$$\therefore 5(y-50-x)+3(x+50)+3x=3y+5x,$$

$$5y-250-5x+3x+150+3x=3y+5x;$$

$$\therefore 2y-4x=100,\ 8x-4x=100, \text{ since } y=4x,\ x=25,\ y=100.$$

23. Two persons, A and B, could finish a work in m days; they worked together n days, when A was called away, and B finished the work in p days. In what time would each do it? (Todhunter's *Algebra*, p. 104, Ex. 27.)

Suppose A could do it in x days, *i.e.* $\frac{1}{x}$th a day.

B ,, in y days, *i.e.* $\frac{1}{y}$th a day.

In m days A does $\frac{m}{x}$ths, B $\frac{m}{y}$ths, but they finish it together;

$$\therefore \frac{m}{x}+\frac{x}{y}=1.$$

In n days they do $\left(\frac{n}{x}+\frac{n}{y}\right)$ of it. In p days B does $\frac{p}{y}$ths of it; $\therefore \frac{n}{x}+\frac{(n+p)}{y}=1,\ \frac{m}{x}+\frac{m}{y}=1.$

Solve these simultaneous equations in $\left(\frac{1}{x}\right)$ and $\left(\frac{1}{y}\right)$.

$$\text{Hence } x=\frac{pm}{p+n-m},\ y=\frac{pm}{m-n}.$$

24. A body weighing 6 lbs. is placed upon a smooth plane which is inclined to 30° to the horizon; find the two directions in which a force equal to the weight of the body may act to produce equilibrium. Also find the pressure on the plane in each case (London Matriculation, 1873).

Let us denote the force applied by P, the resistance by R. Then the body is in equilibrium under W, P, and R, and W=P; therefore R bisects the angle between P and W. Hence the construction. Draw the vertical through the point and the normal to the plane at the point, and take a line on the other side of the normal, making the same angle 30° with it as W does. Then this is one direction.

Also for the magnitude of the pressure, resolving normally.

$R=2W\cos 30°=2W.\frac{\sqrt{3}}{2}=W.\sqrt{3}$, for both P and W are inclined at an angle of 30° to the normal in which R lies.

The second direction of P is evidently given by the vertical. W and P, directly opposite and equal, counterbalance one another, and R=0; in other words, the particle is on the point of being lifted off the plane.

25. W. T. F. W., Fort-William.—A plantation in the shape of an ellipse has diameters which measure respectively 110 yards and 73 yards 1 foot; how many stakes will be required to fence it, if they are placed 10 inches apart?

To do this problem exactly, it is evidently necessary to know the perimeter of an ellipse, and this is unfortunately a problem which mathematical analysis has as yet utterly failed to solve. It involves a knowledge of elliptic integrals and higher transcendants. We will, however, give an approximate solution. Let the semi-arc be a and b; then the perimeter of the minor auxiliary circle is $2\pi b$, of the major auxiliary circle $2\pi a$. Now the perimeter of the ellipse must lie between these two, and the method of Least Errors would lead us to expect that we shall be nearest the truth in taking $\sqrt{\frac{(2\pi a)^2+(2\pi b)^2}{2}}=\pi\sqrt{2(a^2+b^2)}$ as the value of the perimeter of the ellipse. Although this is not the exact truth, it is near enough when $\frac{b}{a}$ is not very small. In this case $2a=330$ feet, $a=165$ feet, $2b=220$ feet, $b=110$ feet.

$$\sqrt{2(a^2+b^2)}=\sqrt{2.55^2\{2^2+3^2\}}=55\sqrt{26}.$$

Now $\sqrt{26}=5{\cdot}099$. Hence the perimeter $=\pi\times 55\times 5{\cdot}099$ $=\pi\times 280{\cdot}445$ feet $=$ (taking π as $3{\cdot}14159$) $881{\cdot}043$ feet. And there is a stake every 10 inches, therefore there are $\frac{1}{2}\{881{\cdot}043\}$ stakes, *i.e.* taking the integral part only, 1057 stakes altogether.

As we have said, this is not the exact answer, and, in fact, we cannot be certain of anything except that the number lies between 1050 and 1060. There is *no elementary method* of arriving at a more exact result.

26. PRECEPTOR.—(1) No; the diploma would be useless to you as a teacher in an elementary school.

(2) Currie's *Common School Education* (Stewart & Co.) would suit you admirably.

27. An octagonal prism is 40 feet long, and each side of its end is 10 feet. Required its volume.

General formula for area of an equilateral polygon is $\frac{na^2}{4}\cot\frac{\pi}{n}$, where a is length, and n the number of sides.

Here $a=10$, $n=8$, area $=200\cot 22\frac{1}{2}$.

Now $\cot 22\frac{1}{2}=\frac{1+\cos 45}{\sin 45}=\frac{1+\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}}}=\sqrt{2}+1$.

Hence area $=200(\sqrt{2}+1)$.

Hence vol. of whole prism $=8000(\sqrt{2}+1)$ cubic feet $=19{,}313$ cubic feet, taking $\sqrt{2}$ as 1·414.

28. A hexagonal prism is 50½ feet long, and a straight line across the centre of its end from corner to corner is 30 inches. Required its volume.

Let ABCDEF be the hexagon, join AD, and let fall BL, CM perpendiculars on AD. Then BAF is the angle of a regular hexagon $=120°$ (Euc. I. 32, Cor.).

Hence BAL $=60°=$ CDM. Hence AD $=$ AB cos 60 $+$ BC $+$ CD cos 60 $=\frac{AB}{2}+BC+\frac{CD}{2}=2BC$, as might have been otherwise inferred from Euc. IV. 15, since the centre of the circle circumscribing the hexagon lies at the centre of AD. Hence the length of side is 15 inches $=\frac{5}{4}$ feet. Hence, as before, the area $=\frac{6.(\frac{5}{4})^2}{4}\cot 30°$. Hence volume $=\frac{7575\sqrt{3}}{64}$ cubic feet $=$ (taking $\sqrt{3}$ as 1·7320) 204·9 (approximately).

29. 'NIL,' Holbeck.—We think you will find Clyde's *Geography* far the best—the larger edition, we mean.

30. SUBSCRIBER, Nottingham.—If $a+b+c=0$, show that $2(ab+bc+ca)^2=a^4+b^4+c^4$.

$$(ab+bc+ca)^2=a^2b^2+b^2c^2+c^2a^2+2abc(a+b+c)$$
$$=a^2b^2+b^2c^2+c^2a^2.$$

Also $2a^2b^2+2b^2c^2+2c^2a^2-a^4-b^4-c^4$ (by ordinary formula or by multiplication; see a former number of this Query Column)

$$=(a+b+c)(a+b-c)(a-b+c)(b+c-a)=0,$$

$\because a+b+c=0$.

Hence the rest is obvious.

31. SUBSCRIBER, Meikleour.—There is a certain number consisting of 3 figures; the sum of the digits is 7; twice the sum of the extreme digits is equal to 5 times the mean, and if 297 be subtracted from the number, the digits will be inverted. What is the number?

Let x, y, and z be the digits. Then $100x+10y+z$ is the number.

$$\text{Also } x+y+z=7 \quad . \quad . \quad . \quad . \quad (1)$$
$$2(x+z)=5y \quad . \quad . \quad . \quad . \quad (2)$$
$$100x+10y+z-297=100z+10y+x,$$

i.e. re-arranging and cancelling 99,

$$x-z=3 \quad . \quad . \quad . \quad . \quad (3)$$

(1), (2), and (3) are three simultaneous equations, whence we get at once $x=4$, $y=2$, $z=1$, or the number is 421.

32. To recommend a book on algebra to you, unless you name further particulars, is hard. Hamblin Smith (Rivingtons, price 3s.) is very profuse in his explanation of difficulties. Todhunter's smaller work (Macmillan, 2s. 6d.) will carry you as far, and in a more scientific, though not so easy fashion. Todhunter's larger work (Macmillan, 7s. 6d.) is by all means the best, if suited to your requirements.

33. ALGEBRAIST, Montrose.—(1) Factors for x^2+4x-1, and similar sums.

Solve the quadratic in x:—$x^2+4x-1=0$, $x=-2\pm\sqrt{5}$. Hence the factors are $x+2-\sqrt{5}$, and $x+2+\sqrt{5}$.

In general, $ax^2+bx+c=a(x-\alpha)(x-\beta)$, where

$$\alpha=\frac{-b+\sqrt{b^2-4ac}}{2a},\quad \beta=\frac{-b-\sqrt{b^2-4ac}}{2a}.$$

(2) There are x students in one class, y in another, but z attend both. Find an expression for the whole number of students. $x+y-z$, as is surely evident.

(3) The angles of a four-sided figure, taken in order, are as the numbers 1, 2, 3, 4. Prove that two opposite sides are parallel. Let x, $2x$, $3x$, $4x$ be the angles. Then, since sum of angles of a quadrilateral is equal to 4 right angles,

$$x+2x+3x+4x=360,\ x=36.$$

Hence the angles are 36°, 72°, 108°, 144°; and as $36°+144°=180°=72°+108°$, it follows by Euc. I. 28 that two opposite sides are parallel.

The sides of a triangle are 6, 7, and 8. Find the segments into which the bisector of the mean angle divides the opposite side.

The mean angle is the angle opposite side 7. Let the segments be x and $7-x$, x being near to the angle formed by 6 and 7.

Then by Euc. VI. 2, $6:8::x:7-x$;

$\therefore 6:14::x:7$, *componendo*;

$\therefore x=3$; $\therefore$ the segments are 3 and 4.

34. PUPIL TEACHER, Stratford.—We must refer you to any work on Trigonometry or Geodesy for the method of measuring mountains.

35. The publisher of Brook-Smith's Arithmetic is Macmillan & Co., price 4s. 6d.

36. Oranges are bought for 2s. 6d. a hundred; some are sold at 3s. 6d. per hundred, and the rest at 2s. 10½d. per hundred. The same profit is made as if they had all been sold at 3s. 1½d. a hundred. Of 1000 oranges sold, how many fetch 3s. 6d.?

Suppose x fetch 3s. 6d., then $1000-x$ fetch 2s. 10½d., and total receipts are $\frac{7x}{2}+\frac{23(1000-x)}{8}$ shillings. But we are told also that these receipts are the same as if all had sold at 3s. 1½d.

$$\text{Hence } \frac{7x}{2}+\frac{23(1000-x)}{8}=1000.\frac{25}{8},$$
$$\text{or } 28x+23000-23x=25000;$$
$$\therefore 5x=2000,\ x=400.$$

37. J. S., Dumfries.—Solve (1) $x^2+y=4$.

(2) $y^2+x=10$.

Substituting from (1) in (2) for y,

$$(4-x^2)^2+x-10=0;$$
$$\therefore x^4-8x^2+x+6=0;$$
$$\therefore x^4-8x^2+7+x-1=0;$$
$$\therefore (x^2-7)(x^2-1)+x-1=0;$$
$$\therefore x=1 \text{ or } (x+1)(x^2-7)+1=0. \quad . \quad (3)$$

The value $x=1$ gives $y=3$, and this is the only solution which is both rational and integral.

The cubic equation (3), which gives us others, may be dealt with thus:—Write it $x^3+x^2-7x-6=0$. Since it consists of a set of positive terms followed by a set of negatives, it has only one real root (see *Theory of Equations*).

Call the equation $f(x)=0$. Then $f(2)=-8$, $f(3)=9$; hence the root lies between 2 and 3. Put $x=2+\frac{1}{y}$, and multiply by y^3. The equation becomes $8y^3-9y^2-7y-1=0$. If this expression be $\phi(y)$, $\phi(1)=-9$, and $\phi(2)=13$. Hence there is a root between 1 and 2. Hence, finally, the only other value of x that is real is about $2\frac{3}{4}$, whence $y=-2\frac{3}{4}$ about. Or the equation might be dealt with in the ordinary way for cubics.

38. Write again more definitely for instructions as to Science and Art Mathematical Examination, stating what proficiency you have attained, and what books you have read. We shall then be glad to advise you.

39. Subtract—

mls.	fur.	po.	yds.	ft.	in.
8	0	0	0	0	0
7	7	39	5	2	10

The latter quantity $=8$ miles 1 ft. $+4$ inches. Hence, if required to subtract the second from the first, the answer is -16 in.

40. H. M. M.—Write to Mr. James Jennings, Deptford, S.E., and Mr. Tudor Rogers, Chester.

41. T. ELLIOT, Grindal School, Yorks.—The 'fish' is not a fish at all, but one of the cuttles—the Common Squid. The circular cups on the arms are for suction, in order to capture prey. There is a full account of it and its relatives in Wood's *Illustrated Natural History*, vol. iii.

*** *In communications to this column, correspondents must in all cases remember to send us their names, not necessarily for publication, but as a guarantee of good faith, and for facility of reference.*

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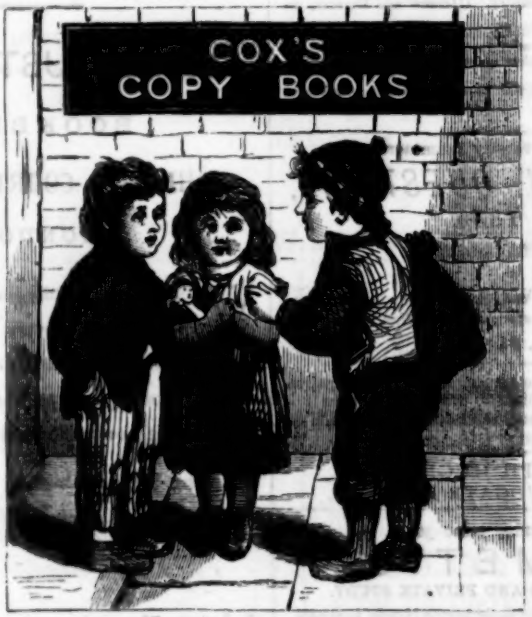

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